ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVIII. No. 22. NEW YORK, SATURDAY, JUNE 2, 1906. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. L. W. MARSHALL, Manager
BOSTON OFFICE: Delta Bldg., 10 Post Office Square, M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad St., London, E. C., HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single copy, 10 cents. Back numbers, beyond one month, each . . .25

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A POSSIBLE APPLICATION OF ELECTRIC OSMOSIS.

By electric osmosis is meant the transference of liquids under the influence of the electric current. As is well known, an electric current passed through a liquid may cause the latter to move as a whole. This action is, of course, different from the electrolysis of a solution, as in the latter case constituent particles are set free at the two electrodes of the system. One of these liberated substances must, of course, travel some distance, at least, with the current, while the other moves in the opposite direction. By osmosis, on the other hand, is meant the movement in one direction either of the entire liquid or of some part of it. This action is shown by means of a porous diaphragm which resists, to some extent, the tendency of the liquid to maintain a level at all parts. The same action may be shown by means of colloids, which move bodily either with or against the current, according as they belong to the negative or the positive group. If the liquid be dispersed throughout a solid material, so that it does not quickly reach its level, the same action may take place and the equilibrium of the system be disturbed. Such an arrangement is, for example, earth containing moisture. If a current be passed through dry earth—that is to say, earth which is so dry that a change in the amount of moisture at one part is easily discernible—it will be found that the water travels with the current and collects about the negative electrode. An interesting experiment demonstrating this was made not long since by Mr. F. Fernie, which is referred to in the *Electrician* (London) in connection with the breaking down of the insulation of buried electrical conductors. Mr. Fernie took a glazed pipe and placed the lower end in a wooden box, which was then filled in with bitumen and the whole system buried in the ground so as to leave a few inches of the pipe projecting above. Copper wire was wound around the outside, and another spiral of wire placed in contact with the inside. It was found that although this pipe was allowed to stand two weeks no moisture worked its way in, but when an electric current was passed between the two wires, water immediately began to work its way through the pipe, although it was heavily glazed, and within two days the pipe was half full of water. In this case a voltage of 230 was employed.

This action suggests the idea that electrical osmosis might be applied to supply moisture to plants. Very probably, under most conditions, such application would be of little value, but occasion might arise in which it could be used with good results. It is well known that experiments have been made at various times to see whether the electric current might not act as a stimulant when passed through the ground and in this way hasten the germination of seeds and the growth of plants.

This transference of water under the action of the electric current could be employed to bring the moisture dispersed throughout the ground to the roots of plants and thus make it available for them. Suppose, for example, that during an exceedingly dry season an electrode were inserted in close proximity to each plant which was to be benefited, and a number of other electrodes were placed at intermediate points, from which

the water might be taken without doing any harm. If, then, a current be passed into the ground through the latter set of electrodes and taken out by means of the other, all the moisture contained in the ground will migrate toward the plants. They might in this way be supplied during the most severe drought, for if the positive electrodes were made long enough, they would, when the upper layers of soil were exhausted, draw it from those still deeper. The current required to do this could be supplied from any available source. Primary batteries might be used, but they would probably be rather expensive. It is possible that a number of zinc and copper plates, buried in the ground some distance away, would do the work, or the positive electrodes themselves might be made of zinc. This would, of course, be at the expense of the zinc.

It is improbable that this effect of osmosis could be employed generally in agriculture with profit. It would be somewhat expensive, and, under most conditions, not necessary. It would very likely cost a great deal more than it would to carry water to the plants; but one can imagine a condition in which the scheme might be used to good effect, when, for example, plants were dying for lack of water and the water supplies were so low that none could be spared for them. It will be interesting, in any event, to try the plan during some dry season.

A REFUSE DESTRUCTOR AND ELECTRIC LIGHT PLANT COMBINED.

The destruction of city refuse by burning seems to be accepted as the most satisfactory method, on the whole, and has been adopted by a great many cities, various methods being employed. Since the burning of the refuse sets free more or less heat, it was suggested some time ago that this heat could be utilized for power purposes. This has now been done in a number of cases, notably in England, where the municipalization of public utilities has probably contributed a good deal toward the combination. In this country, although the plan has been considered, it has been tried in but two instances. One is the small plant in the city of New York for lighting the new bridge across the East river. Here there is a refuse destructor operated in connection with the lighting plant, which supplies steam to the latter.

The other exception is more important, for it is an installation designed to handle all the refuse of the town and to work in connection with the municipal lighting plant. This town is Westmont, a city of some 12,000 inhabitants, situated a short distance from the city of Montreal, in the province of Quebec. Up to the present year the city refuse had been disposed of by carting it and dumping on unoccupied land. Last year, however, it was decided to install a destructor and to run it in connection with an electric lighting plant. The Meldrum system, well known in Great Britain, was adopted, upon which construction was begun in the fall. The plant is now nearing completion. The destructor part is so far advanced that tests were made upon it early in May. The report of the test, as given in the *Engineering News* for May 24, shows that the destructor did all that it was designed to do, and that it was capable of handling a good deal more refuse than is at present to be disposed of.

The destructor plant consists of three grates. The refuse is fed in at the top and distributed by doors at the back and front. The hot gases from the furnaces are passed through a water-tube boiler and then through a regenerator, where they heat the air which is supplied to the furnaces under forced draught. A high temperature is reached, and all combustible material is burned, leaving a clinker which is good for road making. No smoke or odors are given off. The test showed that an equivalent of 1.36 pounds of water from and at 212 degrees Fahrenheit could be evaporated per pound of refuse. The refuse has been burned just as it was received, with the exception that large incombustible materials were picked out. About sixty-five per cent of this refuse was made up of ashes, cinders and unburned coal. The remainder was garbage and dry refuse of all kinds. The refuse usually disposed of in such destructors does not contain the ashes.

The estimates made by the engineers in connection with this installation show that, under the most favorable conditions, the cost of the plant will be about $55,000. The expense of operating it, including interest, depreciation, repairs and running expenses, will amount to $7,057. The amount of refuse to be handled, it is estimated, will have a calorific value equivalent to that of 1,000 tons of coal. The steam produced in this way, which is used in the electric light plant, has a value of $4,000. The clinker can be sold for about $250. This leaves about $2,807 as the expense of burning the refuse. To this expense must, of course, be added that of hauling the material to the destructor. This item amounts to a little over fifty-two cents a ton. The cost of burning is 43.3 cents per ton, making the total cost per ton 95.7 cents. As the cost of the present dumping system is merely that of hauling, the new system will cost about $2,170 more than the old, and it is, of course, well worth it. The destructor itself will cost about $14,000. This does not include the cost of the boiler and chimney.

These are excellent results. It should, however, be remembered that it would seldom, if ever, happen that an electric light plant could depend entirely upon a city refuse plant for its fuel. The latter could be looked upon only as a secondary supply, though, of course, it should be utilized and not wasted. Further, a refuse destructor would be undesirable in the city itself, and the place most suitable for it might be very unsuitable for an electric lighting station. In fact, it is probable that a large electric lighting system would consider a refuse destructor as a very unsatisfactory steam supply and on the whole undesirable. There are other factors of more importance to such a system than a slight saving in the cost of steam. Nor when it is suggested that the steam which can be raised in these destructors be utilized is this to be considered as an argument in favor of municipalizing the electrical supply system; that is a question entirely separate from the other. The refuse destructor furnishes a good method of getting rid of city wastes, but while it may be advisable to utilize the steam produced in this way, this is not proof of the desirability to take over the entire burden of the city's electrical supply.

ELECTRIC RAILWAY EARNINGS.

In spite of the activity in electric railway construction, it has been questioned at times whether a good deal of this work was really of a profitable character, and whether a good deal of it was not more or less speculative. This opinion probably is due to some unfortunate undertakings, particularly in a few sections where the construction seems to be running far ahead of the necessities. It is therefore gratifying to learn from the *Financial Chronicle* that, taken as a whole, the electric railways of the country seem to be on a sound financial basis. This journal has recently gone to considerable trouble to compile statistics covering the operations of a large number of electric roads. Unfortunately, it was not able to get statements from all the roads. In fact, certain large and important roads were necessarily omitted. These were, for example, the Chicago Union Traction Company, the St. Louis and Suburban Railway, the Cincinnati Traction Company, and a number of other roads operating at large cities. Figures were, however, secured from 512 roads. These cover periods of one year, though the reports were made up on different dates; all cover at least six months of operation during the year 1905.

The figures given here show total gross earnings of $306,067,145. Comparing this with the figures for 1904, when the gross earnings were $281,608,936, it is seen that the increase is $24,458,209, which is 8.68 per cent. The net earnings are even more favorable. During 1905 they were $130,884,993, while for the previous year they were $118,221,741. The increase in this case is 10.71 per cent. It should be remembered here that a number of these companies operate electric lighting plants, gas plants and some sell electric power. These conditions partially offset the incompleteness of the figures, but do not do so entirely. The *Financial Chronicle* estimates that if the figures from all the roads had been obtained they would show that the gross earnings for the country for the past year were between $350,000,000 and $360,000,000.

From the tables given in this article it is seen that the interurban roads are doing a very large business, and that their business is rapidly increasing. In one case the increase in gross profits was nearly eighty per cent. In another case it was about fifty-five per cent. The net earnings of these companies also show corresponding increases.

These figures, while they appear to show a very satisfactory state of affairs, do not enable a complete analysis of the situation to be made, for no data are given covering capitalization, mileage and expenditures for new work. The figures, however, do show that this method of transportation is growing rapidly, and that the charges for the service more than cover the cost of giving it. These facts are certain to attract the attention of the steam roads, with which the electric roads compete, where this has not already been done. They will undoubtedly have considerable effect upon the railroad situation of the country, and will probably result either in a change in the character of the service offered by the steam roads or in a closer alliance between the two systems. In either case the public will be provided with better traveling facilities, and will naturally acquire the riding habit to a still greater degree.

THE INCREASING DEMAND FOR COPPER.

The increasing demand for copper, due to its extraordinary use in the electrical industries, is dealt with in a recent report to the Department of Commerce and Labor, at Washington. The price for this metal recently attained the highest point since 1888, $418.51 per ton. The average price for the last five years was $301.72. The world's annual production is now estimated to be 700,000 tons. The production for 1905 was 100,000 tons greater than the average for the last five years. The average yearly increase in production before this time has been 748 per cent, and practically all of the important increase has taken place on this continent. The output in the United States for 1905 was 397,909 tons. Mexico produced 60,000 tons, and has doubled her output since 1900. It is estimated, by taking the average increase given above, that the demand for copper by 1910 will be 875,000 tons, and unless some substitute is found for this metal the yearly demand will be 1,500,000 tons by 1920.

The only metal which has been brought forward as a serious competitor for electrical purposes is aluminum, and up to the present time the relative prices of the two metals have not brought aluminum into very wide use. The increasing price of copper should, however, lead to the greater use of aluminum, provided, of course, that the increased demand for this metal does not raise the price. As yet, aluminum has been used only for transmission lines where the larger size as compared with copper, which is necessary to give the same conductivity, is not a disadvantage. For certain classes of work there is no metal which is likely to replace the latter. Although the increase in the demand for copper is sending the price up, there does not seem to be much danger that the producing companies will not meet these demands, for some time at least. Improvements recently made at the large Montana works have greatly increased their productive capacity, and the aluminum works also could probably put out a great deal more metal if it were demanded.

EXPERIMENTS WITH THE TRACKLESS TROLLEY.

The trackless trolley system has been tested recently at Eberswalde, Germany, and some instructive data obtained. According to the *Electrical Engineer* (London), the vehicle weighed 7,496 pounds, and the average consumption, including transmission losses, was found to be 660 watts per kilometre. This gives a consumption of 284 watts per ton mile. The maximum speed attained with the vehicle was eight and three-quarter miles. The cost of this particular system is said to be relatively high, but it is estimated that for a similar line 3.1 miles long, the cost would be, under ordinary conditions, $9,650 for the overhead line; the cars would cost $6,950, and the car shed would cost $2,700, making a total of $19,300. The cost of operating such a road, estimated on the basis of 20,000 car miles per year, is $1,740. This is assuming that the power is furnished to the line at a price of five and one-half cents per kilowatt-hour, which seems rather high. The road at Eberswalde was in operation for a little over five months, when it was withdrawn on account of the unusual cost of construction and of operation. During this time the low fare of three cents was charged, and this is probably a contributing cause to the failure of the system.

The American Falls Power, Light and Water Company, Limited, the Idaho Consolidated Power Company, and the American Falls Power Company.[1]

DURING September, 1901, at Pocatello, Ida., was organized the American Falls Power, Light and Water Company, Ltd., by J. H. Brady, W. S. Chaney, D. W. Standrod and associates. Mr. Brady and Mr. Chaney were from Chicago, and seeing in the great West opportunities which the East did not afford, decided that no better field would be open to them than in Idaho.

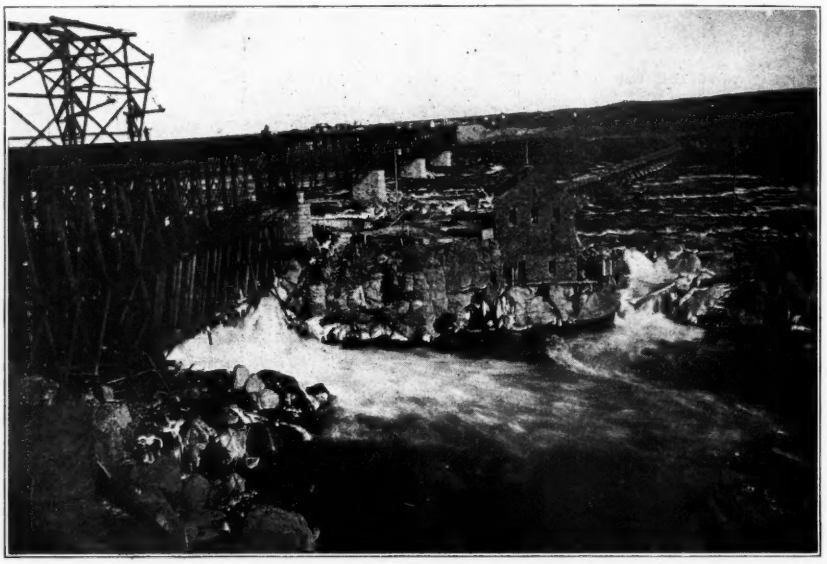
A natural power site with practically an unlimited amount of water power awaiting development being located at American falls, on the Snake river, twenty-six miles west of Pocatello, the American Falls Power, Light and Water Company was organized to develop this water power into electrical energy, the market then consisting of Pocatello, a city of about 5,000 inhabitants; Blackfoot, a smaller city, twenty-six miles north of Pocatello; Idaho falls and Rexburg, twenty-five miles and forty-five miles, respectively, north of Blackfoot, and Ross Fork, the agency of the Fort Hall Indian reservation, located midway between Pocatello and Blackfoot.

The officers of the company were J. H. Brady, president; D. W. Standrod, vice-president, and W. S. Chaney, secretary and treasurer.

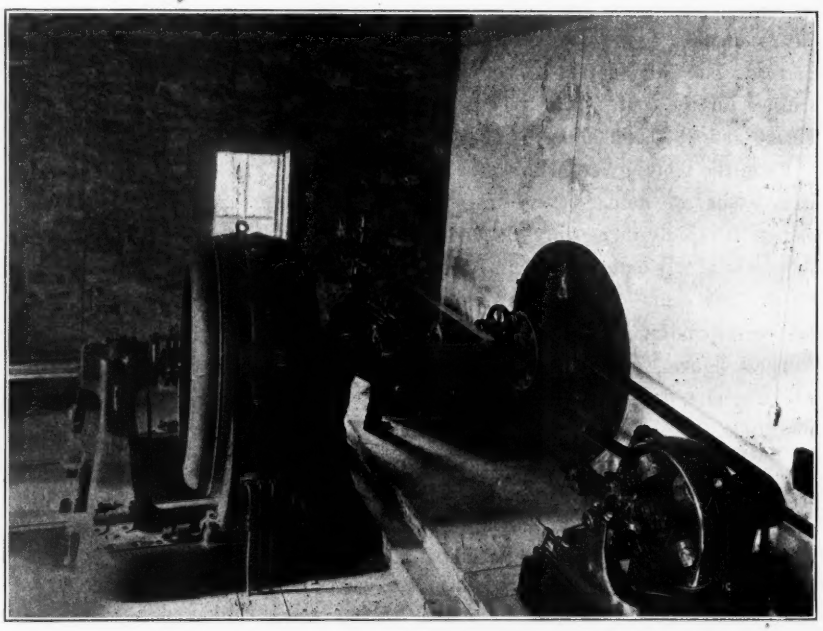
Contracts were at once let to the General Electric Company to furnish all electrical apparatus, and work was started on the construction of the power-house, to be located on an island in the centre of the river, in December of the same year. The station, built of stone, was completed and equipment fully installed by the following August, and as the transmission line and substation at Pocatello were by this time ready, the delivery of current for lighting and manufacturing purposes was begun.

The work of excavating and construction of the generating station, substation and transmission line was carried out both under contract and by the company direct.

The station equipment consists of a General Electric, 500-kilowatt, three-phase, rotating-field type, 2,300-volt, sixty-cycle generator, direct connected to a Sampson special turbine, the latter having four twenty-six-inch wheels in one penstock, operating under a head of thirty-six feet, capable of developing about 900 horse-power. The turbine has a speed of 360 revolutions per minute and is controlled by a Lombard governor. The exciter is a General Electric, 13.5-kilowatt, 125-volt, four-pole generator, belted to a pulley clamped on turbine shaft between the turbine and generator. The switchboard consists of three thirty-six-inch panels with subbases of blue Vermont marble, mounted with oxidized instruments, and a Lincoln synchronizer is mounted on



AMERICAN FALLS POWER, LIGHT AND WATER COMPANY'S PLANT—FROM THE NORTH.



AMERICAN FALLS POWER, LIGHT AND WATER COMPANY'S PLANT—CORNER OF GENERATING ROOM, SHOWING ANOTHER VIEW OF 500-KILOWATT GENERATOR, EXCITER AND TURBINE GENERATOR.

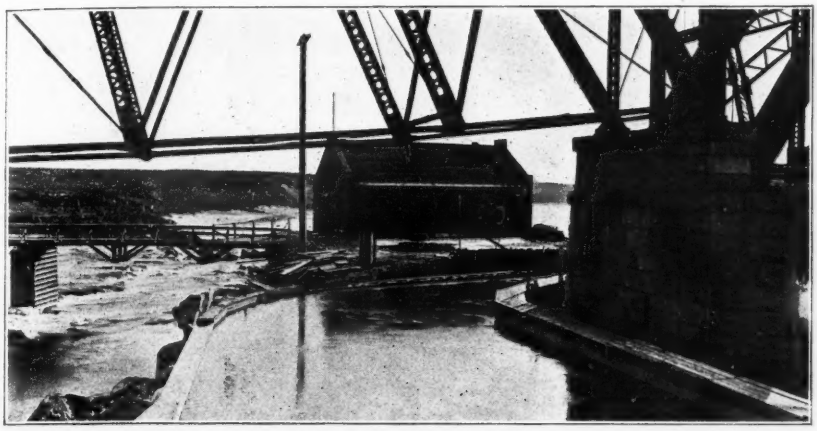
[1] Part of a forthcoming volume on "Hydroelectric Plants of the United States, Canada and Mexico," by A. W. Clapp.

a swinging bracket. Lamps may also be used to synchronize. The switches are oil-break, single-throw, non-automatic.

The switchboard was furnished by the General Electric Company, as were also the transformers, of which there are three in the power-house, of 250 kilowatts capacity each, stepping up the voltage from 2,300 to 33,500, at which tension it is transmitted to the substation at Pocatello. The transformers are of the water-cooled type and are delta connected so that any one of them may be cut out of service if necessary, the remaining two carrying the load.

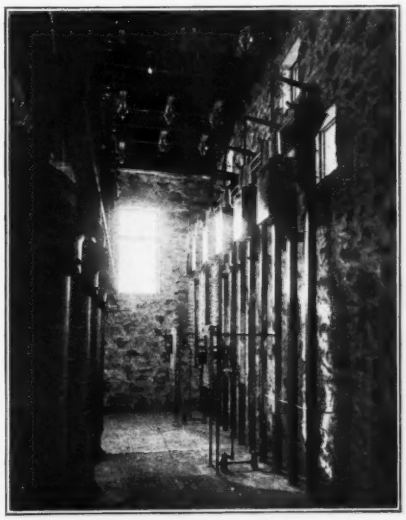
The transmission line to Blackfoot, which is as far north as it runs at present (owing to the small market for power at Idaho falls, where a municipal plant exists) is twenty-six miles in length, running from the Pocatello substation where the switches for disconnecting that line are located. The power is brought into the substation on three No. 4 medium-drawn copper wires from the power-house. The poles on both lines are Oregon cedar, thirty-five feet long, with two wires on the cross-arm and one on the top of the pole, forming an equilateral triangle four feet and four inches between wires. The cross-arms are of native pine, five feet long, and locust pins are used. The insulators used on the line from the power-house to Pocatello are No. 2 Provo and give excellent service. From Pocatello to Blackfoot the Locke triple petticoat glass insulators are used. The poles on both the Pocatello and Blackfoot lines are 110 feet apart. The power is transmitted to Blackfoot on three stranded aluminum wires, made up of seven strands, each of No. 12 wire.

The substation at Pocatello contains at present four water-cooled transformers of 250 kilowatts capacity each, 33,000 volts primary and 2,300 volts secondary, only three of which are at present in use. There is room for two more, to be put in when the power market demands the increase. The wires are brought into the building and immediately enter three General Electric, form K, oil-switches, with automatic attachment, which are located on a suitable framework near the wall and ceiling. There they are tapped, and the three taps lead to a similar set of automatically controlled switches, conveniently located on the same framework, and lead out of the building to the Blackfoot substation. Between the first set of switches and the transformers are placed lightning arresters of the General Electric, alternating, multiplex type, eleven on each leg, and no trouble has ever occurred from lightning since their installation. Between the switches and transformers is placed an impedance coil in each leg. They are



AMERICAN FALLS POWER, LIGHT AND WATER COMPANY'S PLANT—LOOKING FROM THE NORTHEAST, SHOWING THE CANAL BUILT IN THE CENTRE OF THE RIVER, LEADING THE WATER TO THE POWER-HOUSE BUILT UPON A ROCK ISLAND.

AMERICAN FALLS POWER, LIGHT AND WATER COMPANY'S PLANT—POCATELLO SUBSTATION, SHOWING 100-KILOWATT AUTOMATIC REGULATOR ON LEFT, REAR OF SWITCHBOARD, AND FOUR 250-KILOWATT STEP-DOWN TRANSFORMERS ON RIGHT



AMERICAN FALLS POWER, LIGHT AND WATER COMPANY—POCATELLO SUBSTATION, SHOWING HIGH-TENSION OIL SWITCHES AND ARRESTERS.

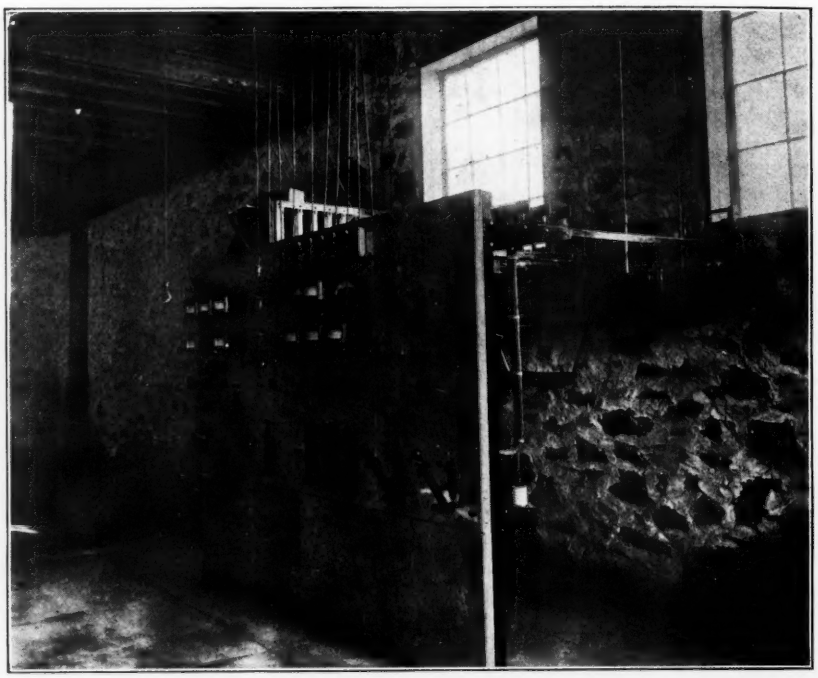
very simple and equally effective, made of No. 4 hard-drawn wire wound spirally in a coil about one and one-half feet long and four inches in diameter, turns being about one inch apart. The primary side of the transformers is delta connected for 30,000 volts, the difference between that figure and the initial 33,500 being lost in transmission. The secondary is delta connected and the secondary leads run to the switchboard, which is of blue Vermont marble and mounted with all necessary instruments. The board is made up of four panels, three of thirty inches in width, five feet high, the other of twenty-four inches in width and same height; each panel is supported upon a twenty-eight-inch subbase with angle-iron frame, anchored to wall six feet behind the board. Between the bus-bars, which are of copper one-quarter inch thick and two inches wide, running full length of board and service lines, is connected a type IRT voltage regulator, the coils of which are immersed in oil which is water cooled. Water is supplied to the transformers and regulator by means of a No. 5 Gould rotary pump belted to a 220-volt, two-horse-power induction motor.

This substation also contains two constant-current transformers of twenty-five-light capacity each, furnishing constant current for fifty-four series alternating arc lamps for street lighting.

Another feature worthy of mention in connection with the substation equipment is a 100-kilowatt, three-phase, sixty-cycle, 2,300-volt generator, belted to a Sampson turbine operating under a fifteen-foot head of water taken at that point from the Portneuf river, a small stream which empties into the Snake river further west. This generator is designed to run in parallel on the secondary side of transformers, if needed, or may be operated singly while repairs are being made on high-tension transformers. Its use, however, is very infrequently demanded. All of the electrical equipment was furnished by the General Electric Company.

Before leaving this article it is well worthy of mention that an eminent electrical authority from Chicago, upon being shown the Pocatello substation, remarked that it was the finest of its kind in the United States, for which due credit must be given Mr. Frank Bletzacker, the constructing engineer.

The substation at Blackfoot contains three oil-cooled transformers of 100 kilowatts each, 30,000 volts primary and 2,300 volts secondary; also the multiplex lightning arresters, identical with those in the Pocatello substation. The switchboard is of three twenty-four-inch by five-foot panels of blue Vermont marble, with twenty-eight-inch subbases, and is mounted with essential instruments, black oxidized and oil switches. The company has also installed in the Blackfoot flour mills a single-panel switchboard with oil switch and three single expulsion fuse blocks, for use with a fifty-horse-power motor; this equipment is also General Electric, as is the single-phase, 100-kilowatt transformer at Ross Fork, stepping down from 30,-



AMERICAN FALLS POWER, LIGHT AND WATER COMPANY—POCATELLO SUBSTATION SHOWING FACE OF SWITCHBOARD.

AMERICAN FALLS POWER, LIGHT AND WATER COMPANY—TRANSMISSION LINE.

000 to 2,300 volts, and single-panel board with subbase, mounted with voltmeter and ammeter, and automatic oil switch.

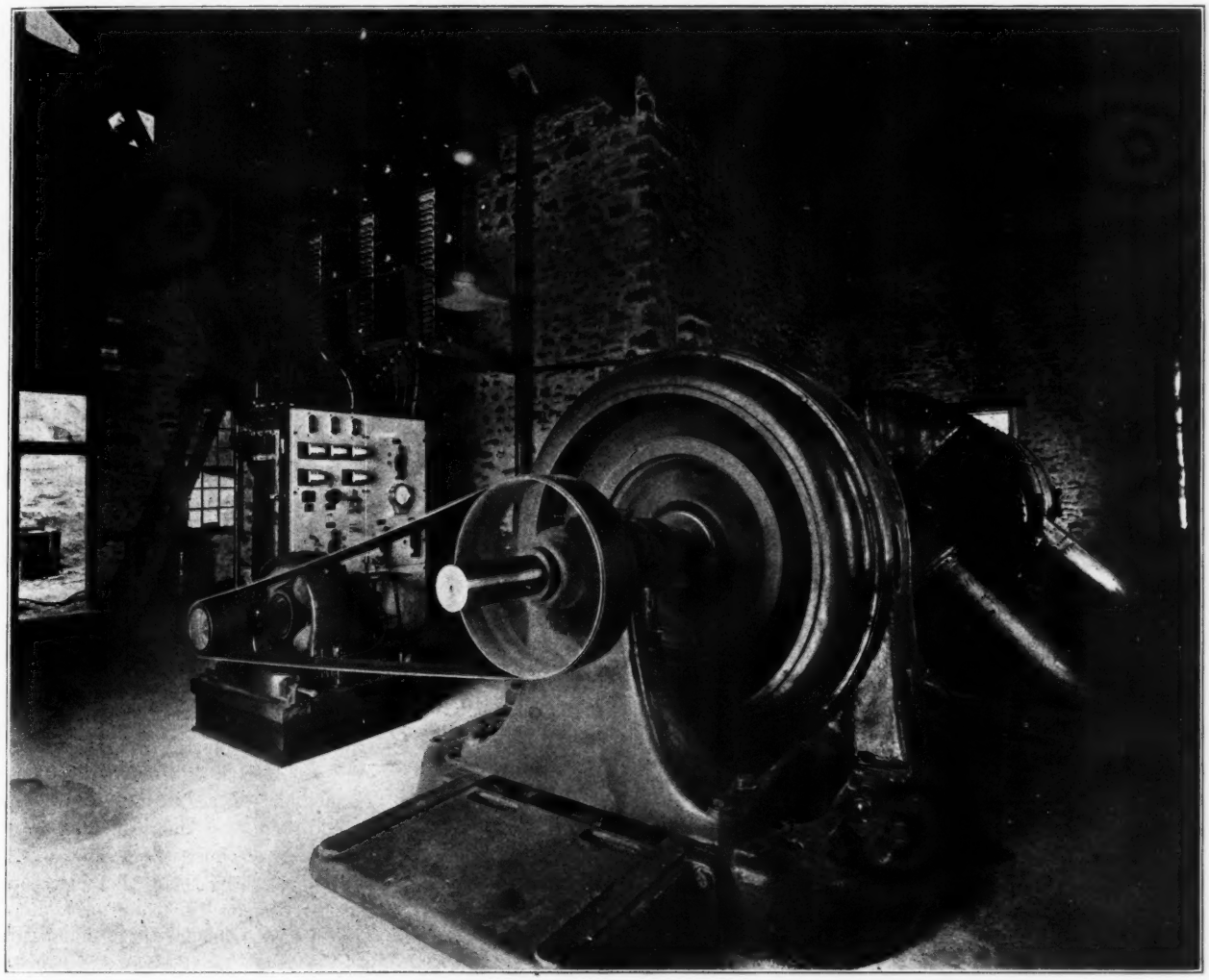
Early in 1904 the need for additional power became apparent and the Idaho Consolidated Power Company was organized. Although the two companies are distinct, the latter was incorporated by the officers of the American Falls Power, Light and Water Company in April, 1904, with A. H. Tarbet, president; W. S. Chaney, secretary; D. W. Standrod, treasurer; J. H. Brady, vice-president and general manager, and R. H. Tschudy, auditor, and June 1 of that year work was started on a power-house located on the west shore of the Snake river about 100 yards west of the American falls station, being completed March 1, 1905.

The equipment in the two stations is almost identical, the only difference being that the switchboard of the Idaho Consolidated plant has but two panels instead of three, and the water is taken to the turbine, which is a Samson special, through a tunnel twelve feet in diameter and 400 feet long, which was blasted through the lava rock which surrounds the falls. The conduit, leading from the tunnel to the turbine, is of wood staves with iron bands around it about two or three inches apart. A short concrete dam is thrown out into the river to divert the necessary water to the intake. Power from the Idaho Consolidated plant is transmitted over the lines of the American Falls Power, Light and Water Company. In fact, the two stations are run in parallel. The town of American Falls is lighted from the power-houses, the current being taken directly from the bus-bars.

With the advent of the gigantic smelters now under construction at Garfield, fifteen miles west of Salt Lake City, a new field for power was opened up and Mr. Brady and associates, taking advantage of the fact and realizing that it would be a highly profitable investment, organized a third company, distinct from the other two, and immediately laid plans for the development of the power going to waste at American falls (for the purpose of transmitting it to Salt Lake, a distance of 170 miles).

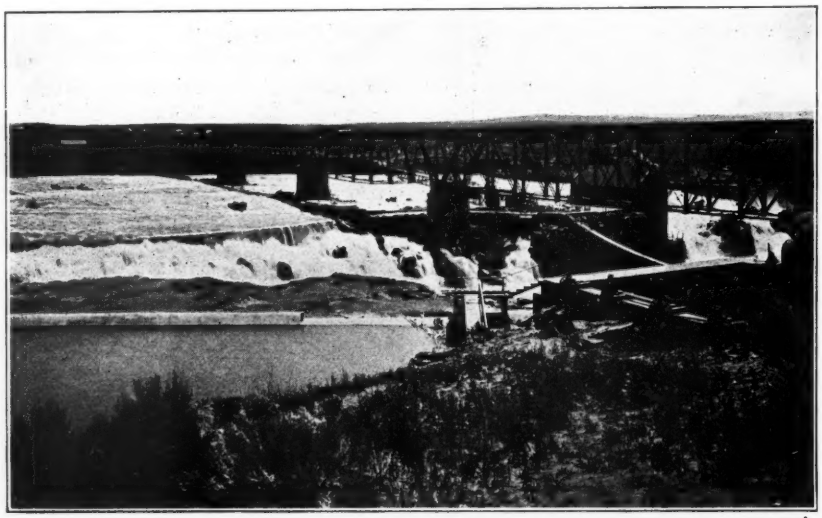
This company was incorporated under the name of the American Falls Power Company with J. H. Brady, president; D. W. Standrod, vice-president; W. S. Chaney, secretary, and R. H. Tschudy, treasurer; F. U. Bliss being general superintendent of the three companies, directing affairs from Pocatello.

The contract for excavating work on power-house site and for flume was let September 18, 1905, and work was started the following month and will be pushed to completion as rapidly as possible. The first installation will consist of three 2,500-kilowatt direct-driven units connected to



IDAHO CONSOLIDATED POWER COMPANY—GENERAL VIEW OF GENERATING ROOM, SHOWING SAMSON SPECIAL TWENTY-SIX-INCH TURBINE, 500-KILOWATT GENERATOR, EXCITER, SWITCHBOARD AND ARRESTERS.

three turbines of 4,500 guaranteed horse-power each, operating under a forty-five-foot head. The ultimate capacity will be six units similar to those to be immediately installed.



IDAHO CONSOLIDATED POWER COMPANY'S PLANT—GENERAL VIEW OF BOTH WING DAMS OF AMERICAN FALLS POWER, LIGHT AND WATER COMPANY'S AND IDAHO CONSOLIDATED POWER COMPANY'S PLANTS. ALSO SHOWING HEAD-GATES AND INTAKE RESERVOIR OF IDAHO CONSOLIDATED PLANT.

The prospective market for the power generated at the three stations, besides that in this state, will be at Ogden, Salt Lake City and Garfield, Utah, to which points power will be transmitted on six No. 000 copper wires, supported on steel towers not less than fifty feet in height and about 500 feet apart. The line pressure will be 60,000 volts.

The ultimate output of the three generating stations will be 16,000 kilowatts, or over 21,000 horse-power, without overload, and as the turbine capacity behind the generators will be 30,000 guaranteed horse-power, without overload, it is safe to depend upon that amount of power for the peak load.

AMERICAN FALLS POWER COMPANY—GENERAL VIEW OF POWER-HOUSE SITE DURING EXCAVATION.

The river at American falls is 900 feet wide, and the falls are the results of great lava overflows which lie on top of the sedimentary formations that form natural dams. The distance from the crest of the falls to still water below is 854 feet, and the fall in that distance is forty feet. The dam, when completed, will be five feet high, constructed of solid concrete, thus giving an effective head of forty-five feet. The fall in the river for twelve miles above the dam is almost imperceptible, and by building the dam five feet high a reservoir from 900 feet to 2,000 feet wide will be secured, with an average depth of five feet for almost eight miles, then tapering off to grade about twelve miles.

American falls is located about eight miles below the junction of the Portneuff river with the Snake river, and is about twenty-five miles from Pocatello. The Oregon Short Line Railway crosses the Snake river at this point on a steel truss bridge. The drainage of the Snake river above American falls is over 20,000 square miles. The average winter flow of the river is 7,000 cubic feet per second, and the lowest minimum flow ever known was in 1901 when it reached 2,100 cubic feet per second. Since that time the Twin Falls Land and Irrigation Company and the United States Government Reclamation Service commenced the construction of very extensive irrigation works, thirty and fifty miles below American falls. These combined works will require 7,500 cubic feet of water per second, and as there is no increase in the flow from the American falls to Twin falls, they are depending entirely on storage water for the extra 5,500 cubic feet. This will give a minimum flow during the irrigation season, which is the low-water season, of 7,500 cubic feet per second. These irrigation works below American falls are well under way of construction, and over $3,000,000 has been spent on the same and the government has made an appropriation of $2,600,000 for the Minidoka project, making in all, almost $6,000,000 that will be expended in the works below the falls, with 5,500 cubic feet per second of water to be secured from the Jackson lake above American falls.

Aside from a commercial standpoint, the falls present a distinct scenic attraction. One standing on the eastern bank of the river, sees the immense volume of water rushing over the rocks for a distance of 900 feet beyond, while on the other shore rises a sheer cliff of vari-colored lava rock, with its rugged outlines against the sky in the distance.

Thanks are due to S. L. Case, chief electrician, for the data contained in this article.

The Twenty-third Annual Convention of the American Institute of Electrical Engineers.

Milwaukee, Wis., May 28 to June 1.

By Telegraph to the Electrical Review.

MONDAY MORNING SESSION.

THE twenty-third annual convention of the American Institute of Electrical Engineers was called to order at 11 o'clock Monday morning, May 28, in the new Public Service Building, Milwaukee, Wis., by President S. S. Wheeler, who called upon C. W. Burkett, a member of the local committee, to introduce City Attorney J. T. Kelley. As Mayor S. M. Becker was unable to be present, Mr. Kelley welcomed the Institute to Milwaukee, offering the freedom of the city and expressing the hope that there would be a most successful meeting. It was most appropriate, he said, that the convention should inaugurate the opening of the magnificent new Public Service Building, which had been erected by the Milwaukee Electric Railway and Light Company. This company was represented at the meeting by its president, John I. Beggs, who occupied a chair on the stage.

Dr. Wheeler delivered his presidential address, the title of which was "Engineering Ethics." Dr. Wheeler referred to Bacon's saying, that every man owes a debt to his profession, which he should recognize and pay as he is able. Every one should endeavor to uplift his profession and carry it forward. To this end the ethics should be well recognized. In the learned professions this is true, but the public, while classing engineering as a learned profession, does not accord it the same high standing. It should be the effort of each engineer to change this condition and to stand on the same high plane. Electrical engineering is the youngest branch, and as yet no definite stand in the matter has been taken. In the other branches the matter has been more discussed and codes laid out to guide those who can not decide such matters for themselves. Abstracts of these codes were quoted.

Dr. Wheeler divided the duties of the engineer into three parts—first, his duty to his client; second, his duty to the public, and, last, his duty to his society.

His duty to his client requires that he give the best he has. Many prominent electrical engineers are affiliated with manufacturing organizations, and should be even more careful to give unbiased advice. It is the custom at present for the engineer to retain drawings and data of his clients' work, and these should be guarded strictly. Work done for corporations should be as thorough and loyal as for individuals.

His duty to the public should require him to lead opinion in engineering thought. Impossible schemes should be exposed and plans of true merit endorsed. This will enhance the opinion held by the public of the profession.

His duty to his society requires that he support it and work earnestly for its good, both for the local organization and for the national society. If a society fails, the fault lies with its members.

Dr. Wheeler then introduced Dr. Samuel Sheldon, president-elect of the Institute, who thanked the Institute for its confidence and the honor conferred upon him. He also acknowledged the assurance of support given him by those who had favored another candidate.

The first paper of the session was by Maurice Milch, Schenectady, N. Y., entitled "The Repulsion Induction Motor."

The author, some years ago, proposed a new type of motor in which starting characteristics similar to those of a repulsion motor were inherently combined with the near synchronous load characteristics of an induction motor. The elements making for the success of this motor included characteristics of the repulsion motor and the commutator induction motor. The paper takes up the characteristics of these motors in detail, and having described the two elements of the apparatus, it is shown that by choosing a particular distribution of ampere turns along the gap of the motor, both elements can be combined in one apparatus. If two armatures representing, respectively, an armature of the Gramme type of a four-pole repulsion motor and a Gramme armature of a two-pole commutator induction motor be coupled rigidly together, at the same time connecting the primary members of both motors in series, a combination is obtained that, due to its repulsion motor element, possesses a good starting torque, and, due to its induction motor element, some of the load characteristics of such a motor near synchronous speed; for, when starting, the induction element will merely represent an impedance in series with the repulsion motor, without adding any torque to the combination. With increasing speed, however, the impedance of the induction motor element rapidly increases, and consequently it will drain the line voltage of the combination into its own circuits, thereby impressing upon the combination its own characteristics more and more as synchronism is approached.

The paper showed that the induction motor element does not possess any torque at synchronous speed. At this speed, however, the repulsion motor carries the magnetizing current of the commutator induction motor connected in series with it, and, due to its consequent torque, drives the induction motor above synchronism up to a speed where the positive torque of the repulsion motor and the negative (generator) torque of the commutator induction motor balance each other. This speed then will be the limiting speed of the combination, and it will act as a motor below this speed and as a generator above it.

Instead of producing this effect by two separate structures, both elements may be blended into one. For this purpose the same armature is used, as the armatures are identical in both elements, and both primary windings are wound into the same slots above each other.

In the discussion of this paper, Dugald C. Jackson, Madison, Wis., stated that he had come to the opinion some years ago that the single-phase system was the best suited to all conditions, and a study of this system led to the opinion that a motor combining the characteristics of the induction motor and the series motor was the most suitable. The systems in view were rather small, as the polyphase systems were more suited to larger work. The slip of the motor, which seems to be larger than given in the paper, can be controlled by the design.

G. P. Cole, St. Louis, Mo., thought that the slip and starting current were both too high for ordinary work, though the motor is suited for elevator and similar service.

Dr. C. P. Steinmetz, Schenectady, N. Y., pointed out that high starting current and high slip go together. The new motor combines the advantages of good starting qualities and fair running

qualities, and will not run away due to the failure of a mechanical device.

The next paper was by Bradley T. McCormick, Cincinnati, Ohio, entitled "Comparison of Two and Three-Phase Motors."

The author presents an analytical study of the characteristics of two-phase and three-phase motors, and gives the following interesting data as a summary:

A two-phase machine should have twenty-two per cent more conductors per slot than the corresponding three-phase Y-connected machine designed for the same voltage and flux per pole.

The magnetizing current is the same in both two and three-phase machines when expressed in per cent of the current which corresponds to the full-load output.

The copper loss of the two-phase machine is twelve per cent higher than that of the three-phase.

The leakage factor of the two-phase machine averages twenty-five per cent greater than that of the three-phase machine.

There can be no doubt as to the higher temperature rise of the copper in the two-phase motor occasioned by the higher copper loss. For the same reason the efficiency of the two-phase motor is slightly lower, the difference depending upon the relative magnitude of the iron and copper losses.

Calculations and tests indicate that the slip in two-phase motors is about twenty per cent greater than in three-phase motors.

Due to the increased leakage the power-factor of the two-phase machine is from one to three per cent lower than on the three-phase motor.

A. S. McAllister thought that the treatment of the subject was too involved and that a surer method was available.

Dr. Steinmetz did not think that there was much difference in the performance of different types of motors if the same volt-amperes were employed for excitation. Practically, the single-phase motor has a slightly lower efficiency, due to the additional transformation which takes place.

C. F. Scott, Pittsburg, Pa., and R. E. Hellmund, Chicago, Ill., also took part in the discussion.

MONDAY, MAY 28—AFTERNOON SESSION.

In the afternoon a session was held at 2.30, when S. Senstius, Cincinnati, Ohio, read a paper on "Heat Tests on Alternators."

The author presents a series of methods developed by him as substitutes for full-load heat tests. These methods are all based on the assumption that the short-circuit test offers the data to predetermine, in a sufficiently accurate way, the regulation of an alternator and also its normal field current and flux.

Dr. Steinmetz called attention to the increasing importance and difficulty of making heat tests. These require large amounts of power and long runs, and hence can not be conducted at the shops. A compromise method must be devised which will lessen the power and time required. One difficulty in conducting long tests is to keep the room temperature constant. The subject should soon be taken up by the standardizing committee of the Institute.

A paper was read by Charles H. Bedell, Bayonne, N. J., entitled "Direct-Current Motor Design as Influenced by the Inter-Pole."

The advent of the inter-pole is due to the demand for motors which operate under conditions so severe that perfect results can not be obtained with those of the standard design.

Having in mind the weak points of standard motors when applied to variable-speed work, the inter-pole motor was designed.

As it is necessary that the commutating field be independent of the main pole, small auxiliary poles with inter-poles are used, placed midway between the main poles, with pole-faces covering the region of commutation. In order that the proper commutating field may be obtained, that will vary with the load, the inter-poles are wound with the necessary number of turns and connected in series with the armature. Thus, when the load on the armature is heavy, the ampere turns on the inter-poles are large, resulting in a powerful commutating field; and when the armature load is light, the excitation of the inter-pole is light, resulting in a weak commutating field—that is, by this construction a heavy commutating field is provided when required, independent of the main field strength, and this commutating field varies with the load until the saturation point of the core of the inter-pole is reached. In the actual motor this saturation point is about 100 per cent overload, well beyond the point of proper operation of the motor.

The discussion on this paper turned on the value of the interpole and the reasons why it had lain dormant for seventeen years.

H. F. T. Erben, Schenectady, N. Y., presented some figures showing the excellent results obtained both with variable-speed motors and with turbo-generators. In the latter it is possible to get ten per cent overcompounding without a series field winding by merely shifting the brushes back, at the same time causing no sparking.

Dr. Steinmetz said that it is only recently that industrial conditions have warranted the additional complication of the interpole. This is due to the demand for wide speed variation and to the reduction of the losses in the machines which has made sparking the loading limit with ordinary designs. The multiple voltage system is excellent, but has a good deal of prejudice to overcome.

Others taking part in the discussion were N. J. Neall, Boston, Mass.; David Hall, Cincinnati, Ohio; S. Senstius, Cincinnati, Ohio, and Dr. S. S. Wheeler.

The value of the interpole for turbo-generators and for railway motors was questioned, replies being made by Messrs. Erben and Bedell. Mr. Bedell quoted excellent results for such motors, and Mr. Erben pointed out the value in generator design when the losses are small. Turbo-generators of 500 kilowatts capacity may now have an efficiency of 96.7 per cent, the loss being only nine kilowatts.

The discussion on local sections was postponed until Wednesday, upon request of Charles F. Scott, chairman of the committee, as it was expected that more western members would be present on that day.

In the evening a reception was held at the Hotel Pfister.

TUESDAY, MAY 29—MORNING SESSION.

On Tuesday morning the meeting was called to order in the University Building, and the following three papers were presented:

"SOME EXPERIENCES WITH LIGHTNING AND STATIC STRAINS ON 33,000-VOLT TRANSMISSION SYSTEMS."

BY FARLEY OSGOOD.

This paper relates the actions of the multi-gap series resistance type of arrester unit and the multi-gap type of arrester unit without the series resistance. The experiences related took place in the years 1904 and 1905, on a 33,000-volt transmission system operated by the New Milford Power Company, of New Milford, Ct. The equipment consisted of six 1,000-kilowatt, alternating-current generators, generating at 1,050 volts and 503 amperes, three-phase, sixty cycles. Before leaving the station the current is stepped up to 33,500 volts by means of single-phase, step-up transformers connected in delta. The step-down transformers at the substations

are connected part in delta and part in Y without grounded neutral. The transmission line is of aluminum wires, being strung on wooden poles and wooden cross-arms. During the year 1904 the multi-gap series resistance type of arrester was in service. The equipment at the power station consisted of sixteen units in series per phase, without any multiplex connections of any kind. These units consisted of four gaps and two 250-ohm resistance sticks each, making a total of sixty-four gaps and thirty-two resistances between each line and ground, and 128 gaps and sixty-four resistances between line and line. On four different occasions, when there were severe lightning discharges on the Waterbury section of the system, the power station system received such increased potential that insulators on the high-tension bus-bars in the generating station were broken down. On two of these occasions the lightning arrester equipment at the power station discharged with sufficient severity to break five or six of the carbon resistance sticks, but on the other two occasions the arrester discharge was very slight indeed.

The most severe storms during the season of 1904 occurred on July 29 and September 8, when, in the first instance, almost continuous flashes were experienced for seventeen minutes, and in the latter instance incessant lightning discharges occurred for twenty-nine minutes. During the storm of July 29 the automatic circuit-breakers opened seven different times, and during the storm of September 8 they opened eight times. During neither of these storms, however, was any damage done to apparatus.

The record for the 1904 season shows that there were nineteen lightning storms, which occasioned fifty-six interruptions to service.

The series resistance type of lightning arrester was abandoned all over the system, and was replaced with the multi-gap type without series resistance. These units consist of twenty-four air-gaps each, and were arranged with fourteen units per phase with multiplex connection without resistance connecting the three phases, and a bank of fourteen units between this multiplex connection and the ground, making a total of 672 gaps between line and line, and a similar number between line and ground.

On July 10 there was experienced the most severe storm that had been known in the section. Soon after the storm struck the system the lines which were being operated in parallel were separated, one line carrying the load, the other being held dead in reserve. Almost immediately after this change was made the arresters at the power station on the working line discharged across the multiplex connection and held an arc which was timed for a little over two minutes, when the breaker was opened by hand to break the arc, the load being put on the reserve line. Examination of the arresters showed that all the cylinders were welded together, including the ground bank, although the cylinders of the ground bank were not so severely melted as the banks above the multiplex connection. None of the porcelain bases was damaged, although the compound from the screw holes was almost entirely melted out and ran down across the face of the porcelain bases. Almost immediately after the load was put on the reserve line this set of arresters acted in the same manner as just described. The operator timed the arc for a little over a minute, and then pulled the breaker to save the arresters.

All the units on all three phases above the multiplex connection had every cylinder welded together. Six porcelain bases were cracked and the compound in the screw holes was almost entirely melted out. Although the bank of units between the multiplex and ground was observed to discharge, the cylinders were not welded together at all. This set of arresters was cleaned up and put back into service, but went out again almost immediately. The welding of the cylinders was about the same as on the first occasion. From this it is clearly seen that lightning will discharge across 672 gaps.

A study of these two seasons of lightning experiences brings out the fact that the trouble has been all over the system, and in no way confined to one point. These experiences seem to indicate that it is the resistance in series with the gaps which cause the greater obstruction to the lightning discharge rather than an increase in the number of gaps themselves.

With the resistance in shunt with a portion of this greater number of gaps, and on account of the flexibility of adjustment of such an arrangement, it is expected that this season's experiences will develop the proper relation between series gaps and shunted gaps; and if such proves to be the case, this type of equipment will be comparatively simple to handle.

"METHODS OF TESTING PROTECTIVE APPARATUS."

BY E. E. F. CREIGHTON.

This paper treats of the methods of testing arresters and dielectrics, and presents most of the conditions and precautions the writer has found necessary to observe to obtain useful results. A second paper will include more details of insulation tests, and will describe the application of tests to some new and some old types of arresters.

The general term lightning has been applied by Dr. C. P. Steinmetz to mean any abnormal surge of voltage on a transmission line. This is a convenient term, since lightning arresters should be designed to protect against any dangerous rise in voltage, whether the clouds are the source or not. This designation will give a natural division of lightning into:

Cloud lightning from an external source.
Surge lightning from an internal source.

Both kinds of lightning usually appear together in summer; that is to say, surge lightning of a more or less serious nature usually follows cloud lightning, as an after effect connected with the extinguishment of the arc. Occasionally, at other times, surge lightning will appear unaccompanied by cloud lightning, due to bad methods or carelessness in switching, accidental grounding of a phase, or a short-circuit.

There is no definite fixed practice in testing lightning arresters corresponding to the well known and satisfactory tests of every other piece of apparatus used in electrical transmissions.

Some of the forms of lightning stroke can not be reproduced in the laboratory. Laboratory demonstrations have often been made of one particular kind and power of stroke in conjunction with a device which protects against that particular condition, but not against a number of other conditions met in practice. As a result, laboratory methods have fallen into disfavor and disuse. This condition is unfortunate, in that apparatus may be installed which is intrinsically unable to withstand even laboratory tests. It seems safe to adopt a rule used in the development of protective apparatus, to the effect that all protective apparatus must pass the laboratory and shop tests before it can be considered ready for the line test; it seems safe to say that sooner or later the arrester installed on the line will be placed under every reasonable condition that can be produced in the laboratory test, and besides, it will be subjected to other strains arising from new conditions, such for example as arise from increased static capacity, distributed capacity and inductance, increased kilowatt capacity of generators, auxiliary oscillations, reenforcement of higher harmonics, disintegration from brush discharge; bugs, dirt, depreciation from use, and so on.

At the same time as stated above, all

the elements are present on the line which could produce the effects of the laboratory tests. For example, although the total distributed capacity and the total inductance of a transmission line may be such as to give a low value of proper frequency, a higher frequency is possible by segmental oscillations on the line, as on a violin string; or a local circuit may be formed of small capacity and inductance, or high frequency may come from a neighboring spark, an arc, or cloud lightning. The range of frequency which must be considered in lightning protection lies between zero frequency (direct current) to about one billion cycles per second. Within this range there are certain values of frequency which may be counted on as absent; such, for example, are the frequencies between zero and the generator periodicity, and also those frequencies lying between the odd multiples of the generator frequency extending over a considerable range above the normal frequency.

The quantities of electricity involved vary from an immeasurably small quantity, through the range of comparatively small quantities tied up at different points of the transmission circuit in the form of electromagnetic and electrostatic energy, into the range of comparatively large quantities involved in line-current flow over an arrester subsequent to the passage of the electrostatic spark. Up to the time the line current starts, the energy involved is inconsiderable, but the power is usually enormous. The successful arrester must be arranged to discharge this energy at its natural maximum rate of discharge. Any restriction of power increases the risk of high-potential strains.

On the other hand, when generator current follows, the almost incompatible condition of restricted power and energy must be introduced. The necessity for the rapid restriction of the passage of the generator power will become more evident when the laws governing the conditions of non-arcing qualities of metals are considered. This part of the subject, including methods of tests, will be taken up later.

Summarizing: the factors of immediate interest are the rise of potential, the quantity of lightning electricity, the proper frequency of discharge, the frequency of recurrence of the lightning stroke, the power of the lightning stroke, the power and energy of the generator discharge.

"PROTECTIVE APPARATUS FOR LIGHTNING AND STATIC STRAINS."

BY H. C. WIRT.

The effect of lightning discharges depends upon the frequency and volume of current. In the case of those arresters using series resistance, it is apparent that the voltage rise around the resistance may be considerably dependent upon the amount of current passed, and this voltage rise is independent of the retardation effected by the so-called skin effect. The author's observation has been that arresters employing series resistance sometimes fail to protect the apparatus. He believes this is due to the rise of voltage around the resistance, together with the skin effect. By making the resistance low, the rise of voltage due to the resistance can be reduced.

These three papers were discussed jointly. The discussion was opened by Dr. Steinmetz, who said the problem of lightning protection is becoming more important. We must not expect to protect a system as a whole, but we should try to protect the station apparatus. The electrical features are most important and it is essential to have the lines but little exposed to lightning. The problem should be taken up before any line work is done and a route selected which is but little exposed. Avoid isolated hills and look for signs of lightning strokes, such as shattered trees. This survey is generally neglected. Next in importance comes the line construction. He believed the best protection is a wire of good conductivity, carried above the line wires and grounded at frequent places. Barbed wire is not reliable, as it is too light. A steel cable carried from pole to pole and drawn tauter than the line wires is good and acts also as a stay. Money put into long poles for this purpose is well invested. Dr. Steinmetz explained how a circuit containing distributed capacity and inductance in series and which is shunted by a similar arrangement can cause an uneven distribution of potential at the gaps of a multigap arrester and thus cause a progressive breaking down of the gaps. The same theory explains long lightning discharges without the assumption of infinite voltages.

P. H. Thomas, New York, showed diagrams illustrating the relations between the inductance and the number of gaps necessary to extinguish the arc when the current of the discharge is constant. The greater the inductance the more gaps are required. For this reason a series resistance is helpful, as it limits the current which can flow through the arrester. Mr. Osgood's paper merely indicates that the resistance used was too large. Laboratory tests are good, as they suggest methods of attacking the practical problems. High-frequency effects can be ruled out, as the energy involved is small. The discussion was participated in by G. B. Taylor, Schenectady; N. J. Neall, P. M. Lincoln, Pittsburg; F. A. C. Perrine, New York, and C. F. Scott, Pittsburg, who pointed out the difficulty of collecting data on lightning troubles—the danger that solutions of the problem at one place might not be suited to other localities. Credit was given to theoretical discussions of the subject presented in earlier years and to the pioneer workers in this important field. The choke coil has done all it was expected to do. Grounding the protecting wires reduces the strain on the lightning arresters. Steinmetz's plan can not always be followed, as in mountainous districts the storms frequently follow the valleys where the line must run. Mr. Osgood said that lightning is the only problem which has not been brought under control. Mr. Creighton said the oscillograph is useless for research in this field, as the frequency of the damaging discharges is too high to be followed.

In the absence of Chairman F. B. Crocker, of the standardization committee, C. F. Scott presented the report. As no discussion had been received through letters as requested, he recommended that the report be referred back to the committee with instructions to re-report to the board of directors, who should be authorized to accept it. Some discussion arose as to the advisability of doing this. Certain features of the report were criticised. Replying, Messrs. Scott and Steinmetz said that the report as it stood was not final, that all discussions submitted would be carefully considered, but if action were not taken now a year's delay would result.

A motion is accordance with Mr. Scott's recommendation was finally adopted and the meeting adjourned until Wednesday, when all the remaining papers were taken up.

On Tuesday afternoon the works of Allis-Chalmers Company, at West Allis, were visited, special cars being run out for the visitors, lunch being served at the works.

WEDNESDAY, MAY 30—MORNING SESSION.

The session on Wednesday morning was called to order at the University Building. W. L. Waters, Milwaukee, Wis., read his paper entitled "Shunt and Compound-Wound Converters for Railway Work."

In a direct-current circuit it is often an

advantage to have a system which is, to a great extent, self-regulating as regards voltage. A series winding on the generator field coils tends to make the voltage at the generator terminals rise as the load comes on the machine. This rising tendency is used to counteract the increasing voltage drop in the feeders and mains, due to increasing load. By changing the series winding on the generator the rising tendency of the terminal voltage can be varied to almost any extent.

In a synchronous converter the ratio of the voltages at the terminals of the sides of the machine is approximately constant and independent of the load on the machines or the magnitude of the excitation—that is, when transforming from alternating current to direct current, the direct-current terminal voltage bears an almost constant ratio to the alternating-current terminal voltage under all conditions; so the only way of varying the direct-current terminal voltage is to vary the alternating-current voltage supplied to the machine. Assuming that approximately constant voltage is supplied at the generator end of the alternating-current feeders, and that the circuit between the generator and the synchronous converters contains sufficient inductance, then the voltage at the synchronous converter end of the alternating-current line can be raised or lowered by introducing a leading or a lagging current into the system. By putting a series winding on the magnets of the converter, the excitation of the machines will be increased as the load comes on, and a leading current approximately proportional to the load introduced in the alternating-current system. This will tend to raise the alternating-current voltage. By means of this system a synchronous converter can be compounded in a manner similar to that employed for compounding a direct-current generator.

Unfortunately, this system presents a number of disadvantages in practice. A series winding is needed on the converter magnets, artificial reactance coils are practically always needed to insert in the alternating-current line so as to bring its reactance up to the required value, and there is need for extra switchboard arrangements. This means increased complication and cost and a loss of efficiency. A compound-wound converter costs about seven or eight per cent more than a shunt-wound converter. Reactance coils usually cost about five per cent of the cost of the converter. The efficiency of the system is lowered probably one to two per cent.

To overcompound a converter and to change the voltage at the direct-current side means that the magnetic flux in the field magnets of the converter must change. There is often a considerable time lag, and the result of this is that the load is varying quickly. The voltmeter needle is kept wandering aimlessly about the scale, indicating anywhere, say, from 500 to 650 volts, the voltage apparently not having any relation to the load on the machine.

Probably the best system for general work is to have shunt-wound converters, standard transformers and no reactance coils. Somewhat overexcite the converter so as to keep the power-factor a leading one at all times, and then leave the machines to take care of themselves, only adjusting the excitation in case they fail to divide the load properly.

In the case of a large station the voltage drop is small and the fluctuations in load are unimportant.

In the case of some substations the voltage will vary with the load on account of the feeder drop. The direct-current voltage will be high on light loads and will fall on full load. For a line with substations at various points this is an ideal condition. When the load is light on such a system it will mean that most of the load on the system is being carried by other stations. The voltage will then be high at the lightly loaded station and lower at the more heavily loaded station. The lightly loaded station will tend to help out the heavily loaded one, resulting in ideal conditions—a tendency to distribute the load proportionately between the stations at all times.

J. B. Taylor, Schenectady, N. Y., did not agree with the conclusions arrived at by the author. For large cities the shunt rotary might do, but for small systems the compound rotary was valuable. It does not cost much more, and it does not affect the efficiency to any extent. The overexcited rotary converter also compounds the generator, which is beneficial. The transformers take the place of inductance coils.

P. M. Lincoln, Pittsburg, Pa., agreed with Mr. Taylor and pointed out that certain large systems, notably the Manhattan elevated system in New York city, have changed over from shunt to compound rotary converters.

Mr. Waters, in replying, held to his opinions as expressed in the paper, and said that the increase in cost amounts to six or seven per cent. The losses are increased, and the use of transformers as inductances calls for special design. The tendency, he thinks, will be toward the simpler shunt machine.

The paper entitled "The Self-Synchronizing of Alternators" was read by Morgan Brooks, Urbana, Ill.

Steinmetz has shown that the synchronizing power of the current that may circulate between two machines in parallel under the normal condition of equal voltage depends upon a lagging current due to the inductance of the short-circuit path through the armatures of the alternators.

To retain this lagging current and its desirable effect, the impedance to be connected in series between the machines should be highly inductive. The authors tried various inductances, such as transformer coils and arc lamp regulators, but with indifferent success. If enough inductance was used to prevent too great an impulsive rush of current, the synchronizing current desirable at slight phase differences was too weak. If the inductance was adjusted to get fair synchronizing power, it was not safe to throw the switch at a very much greater angle of phase difference than without it. The range of safe angle was, however, perhaps doubled.

Pure resistance was next tried, resulting in loss of synchronizing power, since the circulating current did not have the required lag. The use of condensers in series confirmed the theory above outlined, for the alternators now assumed the 180-degree phase relation and retained it with such persistence as to suggest easy synchronizing by using a reversing switch to connect the machines together in the zero phase relation. At this point it was proved by experiment that it was a simple matter to synchronize two alternators through the armature of a third alternator not running, and then by bringing this third machine up to synchronous speed, to observe that it automatically fell into step, forming a delta-connected, three-phase system.

Having control of the synchronizing angle at the 180-degree and the 120-degree positions, it was felt that some way to secure the desired zero angle must be available.

A final idea of trying an inductance without any iron core came opportunely. A trial met with flattering success, and by adjusting the amount of inductance it was found that for a seven and one-half-kilowatt machine a value limiting the maximum current to about half its full-load amperes seemed the best, having due regard to objectionable reac-

tion upon the system as well as to synchronizing effect.

The experiments were tried at sixty-cycle frequency, and the results were all that could be desired. The switch paralleling the two machines could be closed, while the machine to be brought into step was at a standstill, and then, with approximate excitation, it could be started; and on reaching synchronous speed it would automatically fall into step smoothly and with unexpected force, when the excitation could be adjusted and the inductance cut out.

There was no discussion on this paper, and the paper by Charles F. Burgess and A. Hoyt Taylor, Madison, Wis., entitled "Magnetic Properties of Electrolytic Iron," was read.

Iron which has been deposited electrolytically from an aqueous solution is not necessarily a definite product, but varies in chemical composition and physical constitution, depending upon the adjustment of various factors which govern the deposition. High purity is a property frequently ascribed to electrolytic iron, and it is probably a fact that by no other means can iron be purified to as high a degree as is possible by the electrolytic method. It is safe to say that absolutely pure iron has never been produced, either electrolytically or by any other method.

Magnetic viscosity is usually found in rather soft steels of low coercive force, or even in many samples of soft iron.

Dr. Steinmetz related some of his work with non-ferric magnetic alloys. These contained manganese and gave surprising results, certain of them being strongly magnetic. They behave oppositely to iron, as hardening makes them better magnetically. Manganese seems to be a magnetic metal which is normally in an unmagnetized condition. When alloyed with aluminum, zinc or tin this property becomes evident. Dr. Steinmetz thought that our ideas upon magnetization were changing.

D. C. Jackson, C. F. Scott, W. L. R. Emmet and Mr. Weinsheimer entered into the discussion, pointing out the possible value to the electrical art of the large amount of work that Dr. Burgess had done.

The paper by Dr. Edwin F. Northrup, entitled "Measurement of Temperature by Electrical Means," was then read.

Electrical resistance thermometry is possible because very many electrical conductors change in resistance with change of temperature in a perfectly definite manner. The percentage change in resistance of the pure metals with temperature is a larger change than the percentage change in volume of gases, and over twenty-two times as great as the volume change in mercury. Thus, the coefficient of expansion of nitrogen gas is 0.0036738, and of mercury, 0.000180; while the coefficient of increase of resistance of pure nickel is about 0.0041 per degree centigrade between zero and 100 degrees centigrade. A change in electrical resistance can be measured with greater ease and far greater precision than a change in volume of a liquid or gas. A change in either a high or low electrical resistance can very easily be measured when it is one part in a million. In the use of the bolometer, where the electrical resistance method of measuring temperature is carried to its greatest delicacy, temperature changes as small as one ten-millionth of a degree centigrade are said to be easily detected.

The feature of paramount importance in the use of electrical resistance thermometers is the constancy with which they maintain their calibration. This subject has received considerable attention, especially in the case of thermometers made of platinum wire, and the results observed have proved the entire reliability of this material for temperatures not exceeding 800 degrees centigrade or 1,000 degrees centigrade. It is highly probable that other materials will behave in an entirely regular manner if not subjected to too high temperatures.

The best material of which to construct a resistance thermometer depends upon the temperature range to be measured as well as upon the physical qualities of the available materials. Constancy of composition and other practical considerations seem to limit the choice to a few metals, usually in the form of wire. The metal which has received the most study is platinum. It can be used over a very wide temperature range, and can be obtained under the name of Heræus platinum in a state of great purity. This material answers every requirement of resistance thermometry, except that it is very costly. A substitute for platinum should therefore be sought and used where it will serve as well. This substitute should be inexpensive and obtainable in a pure state. It is desirable that it should have a high specific point, with a large temperature coefficient. It should be non-oxidizable under usable conditions and withstand a high temperature without deterioration or permanent alteration in resistance.

An examination of the pure metals shows that these conditions are best met by nickel. The writer has had many thermometers constructed of this wire for temperatures ranging from forty degrees centigrade to 300 degrees or 400 degrees centigrade. Conclusive experiments made to determine the availability of nickel for high temperatures would be very useful. It has a higher coefficient than the purest platinum, nickel being about 0.0041 per degree between zero degrees centigrade and 100 degrees centigrade, and pure platinum 0.0039, and commercial platinum but about 0.002. The specific resistance of pure nickel and pure platinum is in the ratio of about 933 to 1,000.

A determination of the temperature coefficient of the metallic elements usually offers a very delicate test of their purity, and specimens of nickel and platinum which show a low temperature coefficient can positively be considered as impure and inferior for use in resistance thermometers.

Another test of interest, especially on wires intended for use in thermo-couples, is to attach the two ends of a short length to the terminals of a very sensitive galvanometer and to pass a flame along the wire. If the galvanometer gives positive and negative deflections of considerable magnitude, the wire may be known to be unhomogeneous and liable to have parasitic currents set up in it when exposed to high temperatures. A pure nickel and a pure platinum wire should show little of this effect. The paper takes up in detail methods of reading resistance thermometers, describes the slide wire bridge method, the use of dial or decade Wheatstone bridges, and the Kelvin double bridge method. Direct deflection methods of measuring physical quantities as well as temperatures, depending, as they do, upon the calibration of a scale, seldom have the precision of zero methods. They possess, however, the advantage of better showing the variations as they occur in changing quantities, while no manipulative action is required on the part of the observer. Recognizing this principle, the author has designed an instrument which will read temperatures as readily as a voltmeter reads volts.

The instrument can be called a ratiometer, because it measures by direct deflection the ratio of an unknown to a known quantity, irrespective, within wide limits, of the operative current used. Thus, the ratio may be that of an unknown to a known resistance, when the instrument becomes a deflection ohmmeter; or a capacity reactance to a resistance, when it can be used as a speedometer; or, as in the present case, a resistance which changes with temperature to a fixed resistance when it serves as a direct-reading deflection thermometer.

The paper concludes with a chapter on methods of measuring temperatures by means of thermo-couples.

Replying to a question, Dr. Northrup said that there should be no difficulty in constructing an instrument for studying high-temperature steam.

Dr. C. P. Steinmetz offered a resolution authorizing the president to appoint a committee to look into the advisability of drawing up a code of ethics for the Institute. If it seemed desirable after consideration, this committee should proceed to draw up such a code and submit it to the Institute for approval. The motion was carried, D. C. Jackson seconding, and C. F. Scott speaking in favor of the motion.

The paper entitled "The Educational Value of an Electric Test Car," by Thomas M. Gardner, was read by M. K. Akers.

The paper describes the interurban test car of the University of Illinois. This car is operated jointly with the Illinois Central Railroad, and was used when the exhaustive investigations for the electrification of the New York Central & Hudson River Railroad were made not long since. The knowledge acquired from these sources has been of much value, both educationally and commercially.

D. C. Jackson did not think such a car of much value as instructional apparatus, but it is of value as it allows work to be done, and results to be made public which otherwise would not be possible. It also brings the students into contact with the practising engineers, which is of much value.

The paper by Edwin J. Prindle, entitled "The Art of Inventing," was read.

Dr. Steinmetz did not agree with Mr. Prindle. The true work of the inventor lies not in working upon new devices, but in taking old discoveries and making them of use to the world. After this has been done, if he finds certain features of his method are new, he patents them. Credit should be given to the person who brings up the problem.

Mr. Prindle did not agree with Dr. Steinmetz, believing that there is great value in direct invention.

C. F. Scott then discussed the relations of local sections to the Institute, quoting the opinions reached at an informal dinner.

Kempster B. Miller, Major G. O. Squier, Dr. Steinmetz and Dr. Samuel Sheldon took part in the discussion, urging the local sections to greater efforts and to depend more upon themselves. The sections will, however, receive all the support they can ask for from the Institute.

WEDNESDAY, MAY 30—AFTERNOON SESSION.

The first paper at the Wednesday afternoon session was by Dugald C. Jackson, entitled "Economies Derivable from the Use of Relatively Small Water Powers of Low Head in the Middle West."

The author described the electric light company of Janesville, Wis., a city of about 15,000 inhabitants. The situation in Janesville was taken for the subject of this paper because of the unusual fact that the company has been able to utilize three separate water powers, two of which are used for continuous service and the third for peak-load service.

The paper by Percy H. Thomas, New York city, entitled "Some Fundamental Characteristics of Mercury Vapor Apparatus," was read.

Dr. Steinmetz agreed with the author's statements, but disagreed with the explanations. The phenomena described are common to various kinds of arcs, and there is no necessity for bringing up new ideas. Taking up the paper in detail, he said that the various features are not peculiarities of the mercury arc. He thought the explanations rather metaphysical, which did not appeal to him. He did not accept the ionic theory, as he thought that it was something of a fad. Accurate photometric comparisons of lamps giving different colors can be made with the paraffine photometer properly used. There is no limit to the amount of power which can be converted in the mercury rectifier.

H. C. Wirt said that the mercury rectifier was giving good service in arc lighting.

Mr. Thomas, in reply, said that while there was a similarity in all arcs, there was actually a difference, as there is a resistance at the surface of the mercury which is not found elsewhere. Sometimes metaphysics are helpful. He had experienced no difficulty in getting good concordant photometric readings, but these did not give results of practical value. The rectifier is a most useful device.

The paper by Charles M. Heminway, entitled "Safety Devices for Steam Engines, Turbines and Motors," was read by title.

W. L. R. Emmet pointed out the necessity for using safety devices on turbines, as the moving parts are not visible. He described certain devices used for this purpose, and stated that turbines are as safe in operation as rotary converters.

The paper by David B. Rushmore, Schenectady, N. Y., entitled "Electrical Connections for Power-Houses," was read by title. There was no discussion on this paper.

The paper by Edwin R. Weeks, entitled "Some Notes on the Lighting of Churches," was read by A. S. McAllister.

There was no discussion on this paper.

On Wednesday evening there was a trip to Whitefish bay by special trolley cars.

Thursday was given up to visits to industrial plants. W. H. B.

New York and Brooklyn Telephone Companies to Make Sweeping Reductions in Rates.

A reduction in telephone rates, to go into effect on July 1, has been announced by U. N. Bethell, vice-president of the New York Telephone Company, carrying with it reductions for service in the territory covered by the New York & New Jersey Telephone Company.

After July 1 the charge to message-rate subscribers in the boroughs of Manhattan and the Bronx will be $48 for 600 local messages instead of $60 as at present. The pay station charge will be five cents instead of ten cents. The pay station charge in Brooklyn will also be five cents, and there is a reduction all along the line to the more remote points in the entire urban territory served by the New York Telephone Company and the New York & New Jersey Telephone Company.

The rate from Manhattan to Brooklyn and all other nearby points will be ten cents, and to Staten Island fifteen cents instead of twenty and twenty-five cents. The highest rate between the most widely separated points, such, for instance, as Tottenville, Staten Island, and the northern end of the Bronx, will be twenty cents. In addition to this, discounts of from twenty to forty per cent will be allowed to large users of the interborough service, making the actual cost from six to twelve cents. A reduction in the rentals of the extension telephones will also be made to private branch exchange subscribers. After July 1 the rate will be $6 a year each, flat, instead of $12, $9 and $6, as at present. The rates for auxiliary lines, tie lines, extension stations, extension lines and private lines will be modified and reduced.

Work on enlargement to make possible these reductions has been going on for the past six months, and the New York Telephone Company has spent $4,500,000 on construction, as against $1,500,000 in the corresponding six months of the previous year.

One of the most important phases of the new schedule is the extension of the range of local messages, which are to be sent under reduced rates. The territory covered is divided into overlapping zones.

The Twenty-ninth Convention of the National Electric Light Association.

Atlantic City, N. J., June 5 to 8.

FROM present indications the twenty-ninth convention of the National Electric Light Association, to be held at Atlantic City, N. J., June 5-8, is destined to be one of the most successful ever held.

Reservations at the leading hotels indicate that a very large gathering will assemble, and the titles of the papers indicate a series of timely and valuable discussions.

Stronger than ever, this year, will sound the notes of commercialism as apart from the purely technical. During the winter the work of developing a cooperative scheme of working together of manufacturing interests in the matter of concordant and business-getting publicity has been going on, and this will undoubtedly arouse unusual enthusiasm during some of the sessions.

The associate members, the manufacturers, are planning an elaborate exhibition, and the extensive sweep of Young's Pier, it is announced, will hardly hold the representations that will greet the visitors on the opening day.

Apart from the business sessions and the exhibits, a series of entertainments will be arranged, and as Atlantic City is famous for an amusement and recreation resort, there will be such features without end.

The local members have been working hard to ensure a comfortable and well-arranged convention. Mr. H. T. Hartman, in behalf of the Atlantic Electric Light and Power Company, has arranged a special rate for lighting current for exhibitors and the members of the local committee have promised every aid possible.

The following programme has been announced:

TUESDAY, JUNE 5—FIRST SESSION, 10 A. M.

Address of welcome, by the governor of the state of New Jersey, or the mayor of Atlantic City.

President's address, by W. H. Blood, Jr., Boston, Mass.

Announcements—"Report of Committee on Progress," by T. Commerford Martin, New York; "Magnetite Arcs and Mercury Rectifiers," by W. S. Barstow, Portland, Ore.; "Flaming Arcs," by Louis B. Marks, New York.

SECOND SESSION, 2 P. M.

"Report of Steam Turbine Committee," by W. C. L. Eglin, chairman, Philadelphia, Pa.

"Fuel Economy," by J. H. Hallberg, New York.

"Mechanical Refrigeration," by John Myer, Philadelphia, Pa.

"Electric Heating," by James I. Ayer, Cambridge, Mass.

"Line Construction for Overhead Light and Power Service," by Paul Spencer, Philadelphia, Pa.

WEDNESDAY, JUNE 6—THIRD SESSION, 10 A. M.

"Business-Getting Methods," by F. W. Frueauff, Denver, Col.

"How to Make a Small Electric Plant Pay," by D. F. McGee, Red Oak, Ia.

"Some Methods Used in Securing and Retaining Business," by Mathias Turner, Cleveland, Ohio; N. T. Wilcox, Lowell, Mass.; Geo. N. Tidd, Marion, Ind.; R. S. Wallace, Peoria, Ill.; Geo. B. Tripp, Colorado Springs, Col.; Leon H. Scherck, Birmingham, Ala.

"Free Installation of Electric Signs," by John F. Gilchrist, Chicago, Ill.

FOURTH SESSION, 2 P. M.

"Profitable Cooperation," by J. Robert Crouse, Cleveland, Ohio.

"Report of Committee to Cooperate with Lamp Manufacturers on Advertising," by Paul Spencer, chairman, Philadelphia, Pa.

"Grounding Secondary Alternating-Current Services," by Sidney Hosmer, Boston, Mass.

"Report on Protection from Lightning During 1905," by Alex Dow, chairman, Detroit, Mich.

"Report of Committee on the Fire Hazard of Electricity," by H. C. Wirt, chairman, Schenectady, N. Y.

THURSDAY, JUNE 7—FIFTH SESSION, 10 A. M.

"Maintenance and Calibration of Service Meters," by Wm. Bradshaw, Pittsburg, Pa.

"Comparison of Direct Current and Induction Motor Loads," by L. E. Bogen, Milwaukee, Wis.

"Alternating-Current Systems of Distribution and Their Automatic Regulation," by C. W. Stone, Schenectady, N. Y.

"Alternating-Current Elevators," by W. Noble Dickinson, Jr., New York.

"Modern Switchboard Practice with Particular Reference to Automatic Devices," by E. M. Hewlett, Schenectady, N. Y.

"Control of Meters on Electric Light and Power Circuits," by H. D. James, Pittsburg, Pa.

SIXTH SESSION, 8.30 P. M.

"The Meaning and Proper Treatment of the Agitation for Municipal Ownership of Public Utilities," by Everett W. Burdett, Boston, Mass.

FRIDAY, JUNE 8—SEVENTH SESSION, 10 A. M.

"New Illuminants," by Professor H. E. Clifford, Boston, Mass.

"Higher Efficiency Incandescent Lamps in Central Station Service; Their Value and Effect and the Policy Therefor," by F. W. Willcox, Harrison, N. J.

"The Edison System of Southern California," by R. H. Ballard, Los Angeles, Cal.

"Design and Manufacture of Hydroelectric Installations as a Whole," by E. F. Cassell, Milwaukee, Wis.

"Question Box and Wrinkles," by Paul Lüpke, Trenton, N. J.

EXECUTIVE SESSION FOR CLASS A AND B MEMBERS ONLY—8 P. M.

Report of executive committee; report of secretary and treasurer.

"Laws of the Different States Governing Theft of Current," by E. H. Davis, Williamsport, Pa.

"Methods of Current Theft," by C. T. Mordock, Terre Haute, Ind.

"Sliding Scale Method of Public Regulation," by W. H. Gardiner, Jr., Boston, Mass.

"Report of Committee on Rates and Costs," by C. L. Edgar, chairman, Boston, Mass.

"Report of Committee on Standard Rules for Electrical Construction and Operation," by E. H. Davis, chairman, Williamsport, Pa.

"Report of Committee on Public Policy," by Arthur Williams, chairman, New York.

"Report of Committee on Relations Between Manufacturers and Central Station Companies," by Henry L. Doherty, chairman, New York.

Election of officers.

Electric Railway Engineering Preliminaries.

By Sydney W. Ashe.

ELECTRIC railway problems have assumed such extensive proportions during the past few years as practically to eliminate all "rule-of-thumb" engineering methods. Such problems are now considered from an engineering standpoint. They are solved on a per capita basis, with a view to the probable annual revenue per unit of population served. A schedule is prepared to accommodate the traffic most economically and then the electrical features are approached. These embrace questions of motor capacity, location and magnitude of power-house, location of substations, feeder calculations and construction. Throughout the solution of the problem, the elements of reliability of service, the safety of passengers and the schedule speed are considered primarily, with reference to the road's probable earning capacity. Such other elements as first cost, maintenance, and operating expenses are considered with a view to earning a suitable revenue upon the original investment.

Electric railway problems are usually of two kinds, those relating to improvements or extensions of existing systems and those relating to new systems. The latter are more difficult of solution than the former as they involve the careful consideration of a number of variables. A new problem may be taken up in the order indicated by the following table:

TABLE OF CONSIDERATIONS.

Population of community under consideration; probable future growth of community; determination of miles of track which the community can economically support; riding habit; gross income per year; car-miles to be operated per year; determination of number of cars; passengers per car per day; number of miles per car per day; number of trips per car; size, type, seating capacity of cars; determination of motor capacity; graphic time tables; speed time and energy curves; effective current values; tonnage tables; load diagrams; total load diagrams; electrical centre of gravity of track sections; electrical centre of gravity of load of entire system; locate main power-house; locate substations; feeder calculations; construction data.

POPULATION OF COMMUNITY UNDER CONSIDERATION.

The population of small communities may readily be ascertained and statistics are often issued bearing on the population of larger cities. As an illustration tables 1, 2, 3 and 4, showing the relation of traffic and trackage to population in a number of urban centres in the United States are here inserted from the United States Census Reports on Electric Railways for 1902, compiled by S. N. D. North.

TABLE I—SHOWING RELATION OF TRACKAGE AND TRAFFIC TO POPULATION IN GROUPS OF URBAN CENTRES, 1902.

	All Centres over 500,000 Population.	All Centres of 100,000 but under 500,000 Population.	Twenty-nine Selected Centres of 25,000 but under 100,000 Population.	Forty-six Selected Centres of Less than 25,000 Population.
Total population served	10,274,470	5,380,647	1,258,615	718,254
Number miles of track	4,998.89	3,559.82	951.93	485.95
Miles of track per 1,000 of population	0.49	0.66	0.76	0.68
Number of passengers	2,456,542,270	994,327,853	135,842,312	49,179,495
Number of rides per inhabitant	239.1	187.7	107.9	68.5

TABLE II—SHOWING RELATION OF TRACKAGE AND TRAFFIC TO POPULATION IN SELECTED URBAN CENTRES WITH POPULATION OF LESS THAN 25,000, 1902.

Name of Centre.	Population of Centre.	Number of Passengers.		Number of Miles of Track.	
		Total	Per Unit of Population.	Total.	Per 1000 of Population.
Fort Smith, Ark.	11,587	731,553	63.1	8.93	0.77
Riverside, Cal.	7,973	547,051	68.6	9.52	1.19
San Diego, Cal.	17,700	2,220,000	125.4	16.60	0.94
Santa Barbara, Cal.	6,587	814,405	123.6	8.50	1.29
New London, Ct.	17,548	1,320,791	75.3	8.51	0.48
Stamford, Greenwich, Ct.	18,417	1,327,617	72.1	12.69	0.69
Pensacola, Fla.	17,747	998,290	56.2	9.00	0.51
Athens, Ga.	10,245	356,969	34.8	6.53	0.64
Alton, North Alton, Upper Alton, Ill.	17,487	1,497,130	85.6	12.25	0.70
Cairo, Ill.	12,566	870,828	69.3	9.67	0.77
Kankakee, Bradley, Bourbonnais, Ill.	15,708	714,769	45.5	12.73	0.81
Vincennes, Ind.	10,249	450,000	43.9	8.00	0.78
Burlington, Iowa	23,201	1,600,000	69.0	14.50	0.62
Muscatine, Iowa	14,073	365,120	61.5	8.60	0.61
Ottumwa, Iowa	18,197	1,211,028	66.6	10.00	0.55
Atchison, Kan.	15,722	533,867	34.0	9.00	0.57
Wichita, Kan.	24,671	1,460,000	59.2	18.50	0.75
Shreveport, La.	16,013	1,450,000	90.6	8.80	0.55
Biddeford, Saco, Me.	22,267	728,909	32.7	8.15	0.37
Benton Harbor, St. Joseph, Mich.	11,717	1,198,826	102.3	10.50	0.90
Marquette, Mich.	10,058	373,672	37.2	7.00	0.70
Menominee, Mich.	12,818	529,764	41.3	6.71	0.52
Vicksburg, Miss.	14,834	1,188,289	80.1	8.75	0.59
Springfield, Mo.	23,267	1,700,715	73.1	19.10	0.82
Great Falls, Mont.	14,930	939,436	62.9	11.90	0.80
Concord, N. H.	19,632	1,510,856	77.0	12.71	0.65
Laconia, N. H.	8,042	436,171	54.2	8.87	1.10
Long Branch, Deal, Allenhurst, Asbury Park, Bradley Beach, Neptune City, Belmar, N. J.	16,148	3,737,541	231.4	23.68	1.47
Perth Amboy, Metuchen, N. J.	19,485	880,128	45.2	9.06	0.46
Dunkirk, Fredonia, N. Y.	15,743	681,770	43.3	7.00	0.44
Kingston, N. Y.	24,535	2,217,334	90.4	9.16	0.37
Ogdensburg, N. Y.	12,633	478,283	37.9	10.00	0.79
Ashtabula, Ohio	12,949	999,857	77.2	5.75	0.44
Lima, Ohio	21,723	1,375,979	63.3	18.55	0.85
Tiffin, Ohio	10,989	482,000	43.9	7.33	0.67
Zanesville, Ohio	23,538	1,800,000	76.5	10.00	0.42
Sayre, Athens, Pa., Waverly, N. Y.	9,481	1,059,507	111.8	9.11	0.96
Tarentum, New Kensington, Pa.	10,137	622,447	61.4	6.61	0.65
Greenville, S. C.	11,860	537,603	45.3	7.00	0.59
Austin, Tex.	22,258	1,213,703	54.5	13.38	0.60
Waco, Tex.	20,686	1,605,525	77.6	16.29	0.79
Ogden, Utah	16,313	861,910	52.8	11.00	0.67
Burlington, Winooski, Vt.	22,423	1,270,136	56.6	11.22	0.50
Everett, Wash.	7,838	971,650	124.0	9.65	1.23
Ashland, Wis.	13,074	503,658	38.5	7.68	0.59
Janesville, Wis.	13,185	304,398	23.1	7.41	0.56
Totals	718,254	49,179,495	68.5	485.95	0.68

PROBABLE FUTURE GROWTH OF COMMUNITY.

Having selected a site for the location of a railway, it is desirable to study the community's growth. This may be done by plotting a curve of its past growth in terms of years and population and from this an idea of its future growth can be gained. It is well to compare with this the actual growth of similar but older communities of the same industrial development, especially when interpolating the curve of future growth of the community is under consideration. As an example, curves are here plotted for New York city; Portland, Ore.; Albany, N. Y., and San Francisco, Cal.; figures 5, 6, 7 and 8. These curves give the rate of increase of population for different cities for every ten years. In order to determine the rate of increase of population of a given city for any particular year, a tangent should be drawn to its population curve, the tangent touching the curve at a point corresponding to that year. The intercepts of the tangent should then be noted. The relation of these intercepts will be equal to the rate of increase of population. This rate of increase may be either positive or negative, as showing the community's growth or decline. Suppose that the rate of increase of population for San Francisco for the year 1874 is desired. Draw a tangent AA′, as illustrated in Fig. 7, touching the population curve at the point M, which corresponds to the intersection of the coordinates representing the year 1874 and the population 1800. The intercepts in this case designated as AB and A′B are a population value of 40,000 inhabitants and a time value of forty-six years, equivalent to a rate of increase of 870 inhabitants per year. This is obviously equivalent to the slope of the curve at this point. The percentage increase may then be determined by dividing the increase of population, 870 in this case, by the population corresponding to this year, namely, 1,800 inhabitants. This yields a value of 48.2 per cent (870/1,800 = 0.482).

A small source of error in drawing such tangents will be obvious on trial. The method is sufficiently accurate for all practical purposes, however, provided care be taken. It should be employed only in cases where there is a sudden change in the population curve at the last point corresponding to the last census report. These changes sometimes occur, as is evident from an examination of the population curve of Albany, N. Y. The rate of increase of population for this city has fallen rapidly in the past twenty years to 0.8 per cent. Moreover, in the case of what are termed boom cities, such as mining towns, sudden changes are likely to occur. For instance, it is interesting to study the per-

TABLE III—SHOWING RELATION OF TRACKAGE AND TRAFFIC TO POPULATION IN SELECTED URBAN CENTRES WITH POPULATION OF FROM 25,000 TO 100,000, 1902.

Name of Centre.	Population of Centre.	Number of Passengers.		Number of Miles of Track.	
		Total.	Per Unit of Population.	Total.	Per 1,000 of Population.
Pueblo, Col.	28,157	4,065,162	144.4	36.25	1.29
Sacramento, Cal.	29,282	3,948,791	134.9	23.50	0.80
Montgomery, Ala.	30,346	1,849,395	60.9	20.00	0.66
Little Rock, Ark.	38,307	3,841,415	100.3	20.70	0.54
Meriden, Wallingford, Ct.	31,033	2,589,737	83.5	19.50	0.63
Augusta, Somerville, Ga.	42,686	2,360,674	55.3	31.02	0.73
Peoria, Averyville, North Peoria, Peoria Heights, Ill.	60,340	6,750,000	111.9	41.25	0.68
Quincy, Ill.	36,252	2,127,623	58.7	17.38	0.48
Rockford, Ill.	31,051	1,989,080	64.1	23.00	0.74
Springfield, Ridgely, Ill.	35,328	3,532,013	100.0	23.83	0.67
Evansville, Howell, Ind.	60,428	3,629,534	60.1	30.50	0.50
Dubuque, Iowa	36,297	2,391,355	65.9	20.85	0.57
Sioux City, Iowa, South Sioux City, Neb.	34,000	4,138,944	121.7	43.00	1.26
Topeka, Kan.	33,608	2,730,287	81.2	28.63	0.85
Lexington, Ky.	26,369	2,350,682	89.1	15.13	0.57
Bay City, West Bay City, Essexville, Mich.	42,386	1,986,982	46.9	23.30	0.55
Duluth, Minn., Superior, Wis.	84,060	9,418,517	112.0	73.84	0.88
Dayton, Ohio	85,333	14,667,094	171.9	52.88	0.62
Springfield, Ohio	38,253	3,784,338	98.9	28.13	0.74
Altoona, Gaysport, Juniata, Bellwood, Pa.	46,034	4,759,279	103.4	27.50	0.60
Williamsport, South Williamsport, Pa.	32,085	2,582,297	80.5	16.41	0.51
Dallas, Tex.	42,638	6,574,773	154.2	46.30	1.09
Galveston, Tex.	37,789	2,851,603	75.5	35.86	0.95
San Antonio, Tex.	53,321	5,268,627	98.8	45.51	0.85
Salt Lake City, Murray, Utah	56,833	10,631,591	187.1	78.04	1.37
Richmond, Va.	85,050	16,313,560	191.8	43.96	0.52
Spokane, Wash.	36,848	5,028,388	136.5	36.55	0.99
La Crosse, Onalaska, Wis.	30,263	1,706,728	56.4	17.11	0.57
Oshkosh, Neenah, Wis.	34,238	1,973,843	57.7	32.00	0.93
Totals	1,258,615	135,842,312	107.9	951.93	0.76

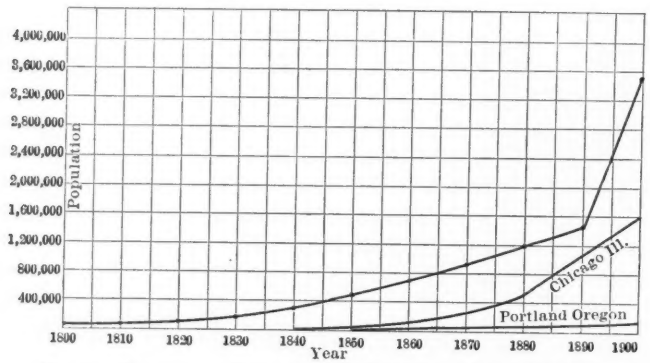


FIG. 5.—GROWTH OF POPULATION, NEW YORK CITY, 1800-1900.

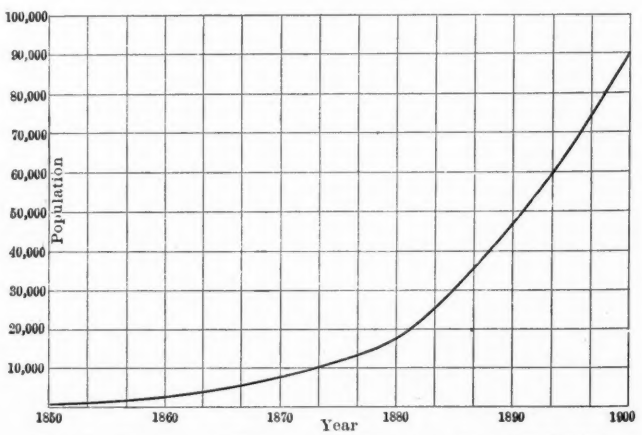


FIG. 6.—GROWTH OF POPULATION, PORTLAND, ORE., 1850-1900.

centage increase of population for San Francisco every ten years from 1860 to 1900. The values are as follows:

Years	Percentage Increase
1860-1870	163.0
1870-1880	56.5
1880-1890	27.8
1890-1900	14.6

It usually follows that the rate of increase of population in cities lowers as the population increases. An instance of this is New York City, which has the following rates of increase:

Years	Percentage Increase
1790-1800	82.7
1800-1810	59.3
1810-1820	28.4
1820-1830	63.8
1830-1840	54.4
1840-1850	64.9
1850-1860	57.8
1860-1870	15.8
1870-1880	28.0
1880-1890	25.6
1890-1900	126.8

The large rate of increase between 1890 and 1900 was obviously due to the formation of Greater New York. The retarding effect of the war of 1812 and the Civil War is also evident. Another interesting study is the case of Chicago, whose rates of increase are as follows:

Years	Percentage Increase
1840-1850	570.3
1850-1860	264.6
1860-1870	173.6
1870-1880	68.3
1880-1890	118.6
1890-1900	54.4

DETERMINATION OF MILES OF TRACK

Granting that the future population which it is desirable to accommodate has been determined, the next important step is to decide upon the maximum number of miles of track which the community in question can economically support. A population value corresponding to a ten-years' growth may be taken as a safe working basis. In deciding upon this future time value, due consideration must be had for depreciation, and the time necessary to operate a road from the beginning of the engineering preliminaries. With large propositions the construction period may extend over a period of three years. In smaller propositions this time may be considerably reduced.

To determine the miles of track refer to Fig. 8, Curve I, which indicates the miles of track per 1,000 of population for various population centres. This curve has been plotted from values taken from the Census Report on electric railways.

Example—Assume the case of a city which has a population of 31,200 inhabitants and is not equipped with any railway service. (It is worth noting here that such cities are scarce in the United States.) Such a city could economically support 0.72 miles of track per 1,000 of population, or a total number of miles of 22.46 (31,200 × 0.72 = 22.46).

Equation A—

Miles of track = population × track factor.

The number of miles of track being determined, this track should be laid out with a view to earning the best revenue, care being taken to avoid as far as possible steep grades and sharp curves.

RIDING HABIT.

Statistics show that with the increase of population of cities and the corresponding improvement of transit facilities passenger traffic is considerably increased. This increased traffic per unit of population has been designated by the term "riding habit." Curve 2, Fig. 8, indicates this point clearly, the curve being plotted in terms of population and the number of passengers per inhabitant. Re-

TABLE IV—SHOWING TRACKAGE AND TRAFFIC IN URBAN CENTRES OF 100,000 POPULATION AND OVER IN 1902.

Urban Centre.	Population.	Miles of Track.	Miles Track per 1,000 Population.	Fare Passengers Carried.	Pass. per Inhabitant.	Pass. per Car-Mile.
Albany, Troy, Rensselaer, N. Y.	216,530	75.83	0.35	26,417,076	122	3.5
Baltimore, Ellicott City, Md.	510,288	365.12	0.72	96,763,878	190	4.1
Boston, Cambridge, Chelsea, Everett, Malden, Newton, Somerville, Brookline, Waltham, Mass.	927,994	451.68	0.49	228,179,308	246	4.8
Buffalo, Niagara Falls, Lockport, North Tonawanda, N. Y.	421,694	320.48	0.76	74,136,881	176	4.3
Chicago, Ill.; Hammond, Ind.	1,769,951	1,036.24	0.58	410,284,094	232	4.0
Cincinnati, Ohio; Newport, Covington, Ky.	429,137	263.57	0.61	86,208,384	201	3.6
Cleveland, Ohio, and vicinity	405,359	237.04	0.58	81,370,202	201	4.3
Columbus, Ohio, and vicinity	127,022	106.43	0.84	26,489,927	208	4.7
Denver, Col.	133,859	149.77	1.12	31,085,443	232	4.8
Indianapolis, Ind.	169,164	109.86	0.65	30,005,026	177	4.3
Jersey City, Elizabeth, Hoboken, Paterson, Passaic, Newark, Bayonne, Orange, N. J.	969,736	463.54	0.48	148,094,623	153	6.0
Kansas City, Independence, Mo.; Kansas City, Argentine, Rosedale, Kan.	237,042	181.24	0.76	57,148,083	241	3.6
Los Angeles, Pasadena, Santa Ana, Orange, Cal.	118,746	164.16	1.38	30,803,086	259	3.2
Louisville, Ky.	204,731	147.13	0.72	34,503,388	168	3.6
Memphis, Tenn.	102,981	71.88	0.70	16,598,823	161	4.5
Milwaukee, Whitefish Bay, Wauwatosa, Wis.	301,701	145.50	0.48	46,974,373	156	5.1
Minneapolis, St. Paul, Stillwater, Minn.	378,923	251.02	0.66	63,009,957	166	4.9
New Orleans, La.	287,104	180.31	0.63	53,184,273	185	3.0
New York, Yonkers, White Plains, Mt. Vernon, New Rochelle, Pelham, N. Y.	3,548,096	1,299.10	1.37	943,687,316	266	5.2
Oakland, Alameda, Berkeley, Hayward, Emeryville, Cal.	101,872	122.80	1.20	17,247,022	169	3.2
Omaha, South Omaha, Dundee, Neb.; Council Bluffs, Iowa	155,268	105.95	0.68	21,418,791	138	3.4
Philadelphia, Pa.	1,293,697	517.53	0.40	331,304,685	256	5.4
Pittsburg, Allegheny, McKeesport, Bellevue, Sharpsburg, McKees Rocks, Carnegie, Wilkinsburg, Braddock, Homestead, Connellsville, Uniontown, Pa.	640,380	469.47	0.73	168,632,339	263	4.9
Providence, Pawtucket, R. I.	268,946	137.05	0.51	45,163,704	168	5.6
Rochester, Irondequoit, N. Y.	178,333	95.86	0.54	20,171,260	113	3.9
St. Joseph, Mo.	102,979	35.15	0.34	8,534,278	83	3.9
St. Louis, Mo.; East St. Louis, Granite, Ill.	614,328	396.21	0.64	129,596,027	211	4.2
San Francisco, San Mateo, Cal.	344,614	276.50	0.80	117,357,877	340	5.7
Scranton, Dunmore, Olyphant, Jermyn, Carbondale, Pa.	155,655	76.68	0.49	8,331,663	54	3.6
Syracuse, Onondaga, Geddes, DeWitt, N. Y.	123,776	68.16	0.55	14,234,508	115	3.8
Toledo, Ohio	135,271	97.78	0.72	20,104,076	149	3.6
Washington, D. C.	279,940	139.67	0.50	63,829,752	228	4.1

Population shown for 1902 is that reported at the census of 1900.

ferring to this curve and to the original problem, it may be noted that for a population of 31,200 each unit of population will ride eighty-two times per year, corresponding to a total annual traffic of 2,558,400 passengers (31,200 × 82 = 2,558,400).

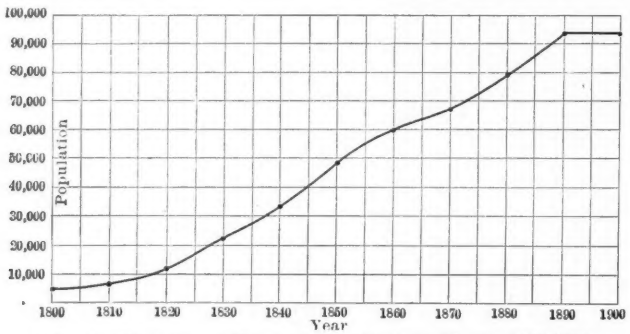


FIG. 7.—GROWTH OF POPULATION, ALBANY, N. Y., 1800-1900.

Equation B—

Yearly passenger traffic = population × riding habit.

GROSS INCOME PER YEAR.

Throughout the United States the average fare per passenger carried for trolley systems is five cents. Steam railways have a method of charging two to three cents per mile of passenger carried, but where the distances are short as with trolley service the average fare is usually five cents. Assuming a five-cent fare, the gross income per year from the passenger traffic is obviously equal to the product of the passengers carried and the average fare, namely, five cents. This, in the example in question, would be (2,558,400 × 5 = 12,792,000) $127,920.

Equation C—

Gross yearly income = total passengers carried × fare.

CAR MILES PER YEAR.

A well-financed road will earn approximately twenty cents per car-mile operated. The number of car-miles to be operated may then be readily determined by dividing the gross income per year by the gross earnings per car-mile. In the example at hand this would amount to 1,750 car-miles per day, or, assuming the road to be operated nineteen hours per day, ninety-two car-miles per hour.

Equation D—

$$\text{Car miles per hour} = \frac{\text{gross earnings per year.}}{\text{gross earnings per car mile} \times 365 \text{ days} \times \text{number hours per day.}}$$

DETERMINATION OF NUMBER OF CARS.

The number of cars necessary for a given service depends upon the schedule speed at which the cars are to be operated and upon the car-miles per hour. The car-miles per hour divided by the schedule speed in miles per hour will give the number of cars. In this example, assuming a schedule speed of 8.5 miles per hour, the car service would call for approximately eight cars.

Equation E—

$$\text{Number of cars} = \frac{\text{car miles per hour}}{\text{schedule speed in miles per hour.}}$$

In many cities the schedule speed is fixed by law.

NOTE—Many methods have been suggested and used with varying success for determining the number of cars for a given service. The foregoing method, in the writer's opinion, is superior to any other. It was proposed by Mr. H. A. Lardner in a lecture before the students of the Polytechnic Institute of Brooklyn and it has been amplified by the writer.

PASSENGERS PER CAR PER DAY.

The total number of passengers carried per year divided by the number of days in a year and the number of cars operated will give the passengers per car per day. In the example in question this will be eighty-eight passengers per day (255,840 ÷ 365 × 8 = 88).

Equation F—

$$\text{Passengers per car per day} = \frac{\text{total yearly passengers.}}{\text{number of cars} \times 365.}$$

NUMBER OF MILES PER CAR PER DAY.

The schedule speed in miles per hour times the number of hours a car is operating will yield the number of miles a car will travel in a day. In the example at hand this will be 161.5 miles per day (8.5 × 19 = 161.5).

Equation G—

$$\text{Miles per car per day} = \text{schedule speed} \times \text{number of hours car operates.}$$

THE NUMBER OF TRIPS.

The number of miles operated per day by a car divided by the length of the line will yield the number of trips a car will make in a day. In the example in question this will be 7.2 trips (161.5 ÷ 22.46 = 7.2) or approximately seven trips.

Equation H—

$$\text{Number of trips} = \frac{\text{miles per car per day}}{\text{length of road in miles.}}$$

SIZE, TYPE, SEATING CAPACITY OF CARS.

The seating capacity of cars varies for

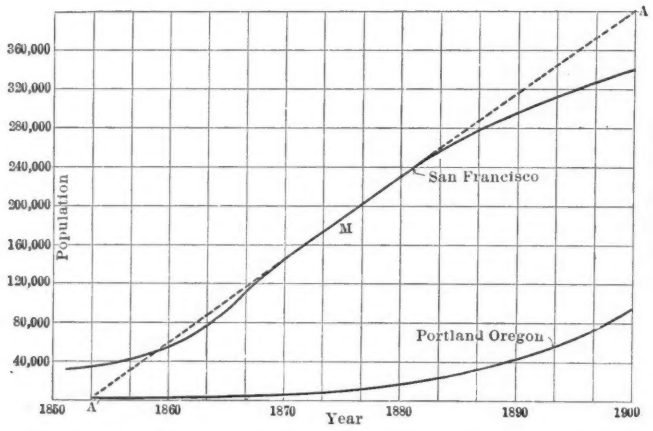


FIG. 8.—GROWTH OF POPULATION, SAN FRANCISCO, CAL., 1850-1900.

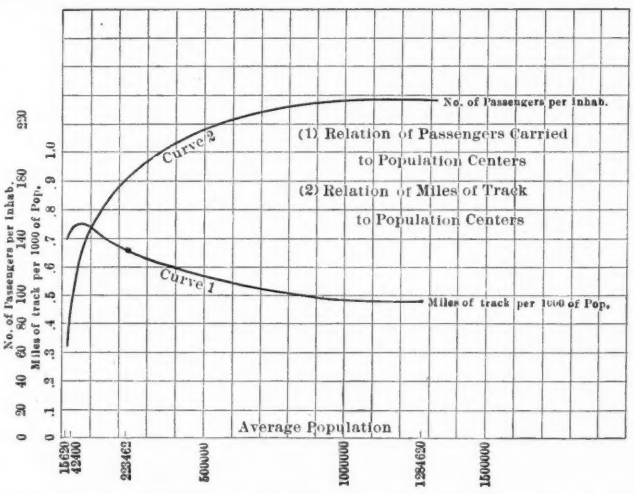


FIG. 9.—RELATION OF PASSENGERS CARRIED AND MILES OF TRACK TO POPULATION CENTRES.

trolley cars from twenty-two persons to ninety persons, as indicated by standard tables. Each car carries, as previously stated, eighty-eight persons per day and makes seven trips. Assume that two-thirds of these passengers are carried during rush hours, four hours, of a day and that the town is located at the middle of the line. Assume also that the schedule is so arranged that all the cars can transport these passengers during this period. Each car would transport about thirty persons ($44 \times 2/3 = 30$). Obviously it would be poor economy to design a system so that its cars could seat its maximum passenger traffic. In this case a car seating twenty-two passengers and accommodating in addition eight passengers standing would be sufficient. An example would be a sixteen-foot Brill closed car having a car body twenty-five feet six inches in length over all. The seating capacity of such cars is figured on the basis of seventeen inches per passenger. The total weight would be 10,700 pounds, including car body, trucks and running gear. Figuring the weight of an average passenger as 125 pounds, this would amount to 7.22 tons [$10,700 + (30 \times 125) = 14,450$, or 7.225 tons].

The writer wishes to express his appreciation for assistance rendered in plotting of curves to Messrs. W. B. Kouwenhoven and Bangs, of the Polytechnic Institute of Brooklyn.

PRELIMINARY PROGRAMME FOR THE ANNUAL CONVENTION OF THE NATIONAL-INTERSTATE TELEPHONE ASSOCIATION.

AUDITORIUM HOTEL, CHICAGO, JUNE 25-28.

JUNE 25.

10 A. M.—Meeting of permanent committee.

1.30 P. M.—Meeting of executive council and advisory board.

JUNE 26.

2 P. M.—Convention called to order.

Address of welcome, the Hon. Edward F. Dunne, mayor of Chicago.

Response, E. H. Moulton, president Twin City Telephone Company, Minneapolis, Minn.

President's annual address, James B. Hoge, president National-Interstate Telephone Association, Cleveland, Ohio.

Officers' reports; appointment of committee; question box.

Adjourn for the day.

MORNING SESSION, JUNE 27.

Meeting called to order at 10 A. M.; report of entertainment committee; discussion of and action by the convention.

Roll call of states.

Paper—"Official Organs—National and State," Charles S. Norton, secretary Indiana Independent Telephone Association, Indianapolis.

Discussion.

Paper—"Look for the Shield," P. A. Walker, general manager Central Iowa Telephone Company, Iowa Falls, Iowa.

Discussion.

Paper—"Telephone Publicity—Appealing to Public Opinion," Ivy L. Lee, New York city.

Adjourn for lunch.

AFTERNOON SESSION, JUNE 27.

Meeting called to order at 2 P. M.

Report of committee on standard forms of accounting.

Discussion and action.

Address on the San Francisco disaster by John Van Liew, president California Independent Telephone Association, Oakland, Cal.

Report of committee on standardization of equipment.

Discussion and action.

Address—"Southern Toll Lines and Exchange Development," by a representative from the Southern states.

Question box.

Adjourn for the day.

Informal banquet, 8.30 P. M.—Colonel J. D. Powers, Louisville, Ky., toastmaster; speakers announced later.

MORNING SESSION, JUNE 28.

Meeting called to order at 10 A. M.

Report of committee on standard operating rules and regulations; discussion and action.

Paper—Suggestions "How to Finance Small Telephone Properties," Theodore Gary, vice-president National-Interstate Telephone Association, Macon, Mo.

Discussion.

Reports of outstanding committees; discussion and action.

Presentation of new business.

Question box.

Adjourn for lunch.

AFTERNOON SESSION, JUNE 28.

Meeting called to order at 1.30 P. M.

Transaction of unfinished business.

Report of nomination committee.

Election of officers; installation of officers.

Farewell address.

In the last report on the Simplon tunnel work it is stated that on March 12 the tunnel was placed at the disposal of Messrs. Brown, Boveri and Company for carrying out the preliminary work for electric traction. The Swiss Geodetical commission were occupied from March 19 to 24 in measuring the length of the tunnel. On March 31 all the electrical fittings and suspension devices were in place ready to take the electric mains.

THE LARGEST MOTOR LOAD IN A MASSACHUSETTS TOWN.

BY ALTON D. ADAMS.

Attleboro, Mass., a town of 12,702 people, has more than 128 motors with an aggregate capacity of between 700 and 800 horse-power connected to the electrical supply system there. No other town in the state can show a motor load of anything like this amount on the electric system, and only eight out of the thirty-three cities of the commonwealth have greater capacities in electric motors operated from central stations.

This large motor load has been entirely built up during nine years; that is, since the middle of 1896. At that time the power load on the Attleboro electric system consisted of two arc motors with a combined rating of fourteen horse-power. The subsequent growth of the motor load is shown in the following table:

Year.	Number of Motors.	Total H.-P.	Average H.-P.
1896.....	2	14	7.0
1897.....	11	41	3.7
1898.....	10	80	8.0
1899.....	15	167	11.1
1900.....	52	414	8.0
1901.....	58	476	8.2
1902.....	94	649	6.9
1903.....	118	713	6.0
1904.....	128	722	5.6

During the period of eight years covered by this table, the capacity of connected motors increased to fifty-one times its amount at the beginning. Arc motors went out of use before the middle of 1897, when the eleven motors operated were all connected to a power circuit, supplied from a 100-kilowatt power generator, which seems to have delivered three-phase, sixty-cycle alternating current. The number and capacity of alternators of this type was increased from time to time with the rise of the motor load, and was 864 kilowatts in 1904. All of the connected motors are of the three-phase, sixty-cycle induction type, and are operated at 110 and 220 volts. In Attleboro there are a number of factories devoted to the manufacture of jewelry and silverware, and these are large users of electric power. Some of the motors are also used in grain elevators, machine and carpenter shops, and in a carriage factory. Many of the power users also take current for lighting, and, at the middle of 1904, there were fourteen customers taking power only. At this same date there were 279 customers using 11,500 incandescent lamps, and thirty of these customers had also ninety-two arc lamps. These figures do not include the street or public lighting, which numbered ninety arcs and 138 incandescent lamps. The

growth of the commercial lighting load during the period covered by the use of the motor load is exhibited in the following table:

COMMERCIAL LIGHTING LOAD.

Year.	Arc Lamps.	Incandescent Lamps.	Customers Using Incandescent Lamps.	Incandescent Lamps per Customer.
1896....	27	525	32	16
1897....	32	907	52	17
1898....	26	968	70	14
1899....	54	1,920	89	21
1900....	63	4,200	108	39
1901....	60	6,240	128	49
1902....	54	10,000	162	62
1903....	93	11,000	224	49
1904....	92	11,500	279	41

From these figures it may be seen that the number of connected incandescent lamps was twenty-two times as great in 1904 as in 1896, the years between which the motor load increased to fifty-one times its initial figure. Another notable feature of the table is the rise in the number of incandescent lamps from sixteen to sixty-two, and then its fall to forty-one per customer. This will be mentioned again in connection with the subject of rates. With the above connected loads the maximum and minimum operating loads on the station, in December and July, respectively, have been as follows, since 1902:

Year.	December. Maximum Load. Kilowatts.	July. Minimum Load. Kilowatts.
1902.....	480	280
1903.....	550	300
1904.....	600	300
1905.....	700	300

In 1896 there were sixty-four arc lamps for public lighting connected to the electric supply system, and in 1904 there were ninety public arc lamps and 138 incandescent, as above noted. The arc lamps were rated at 1,200 candle-power in each year, 117 of the incandescent lamps were of thirty-two candles and twenty-one of sixty-four candles. For street lighting the load has thus doubled. Changes in capacity and type of generating equipment have gone hand in hand with those connected loads, per the following table:

Year.	Horse-Power Boilers.	Horse-Power Engines.	Arc Dynamos. Lamp Capacity.	Kilowatts of Generators for Power and Incandescent Lighting.
1896....	400	700	150	100
1897....	400	700	195	200
1898....	400	700	255	200
1899....	400	700	255	260
1900....	400	750	210	424
1901....	612	750	210	...
1902....	837	1,550	210	924
1903....	949	1,550	...	924
1904....	949	1,550	...	824

From first to last the station has had two water-wheels of seventy-nine total horse-power besides the above equipment. Perhaps the most notable feature of the changes in station capacity here shown is the increase of electric generators of all sorts from about 150 to 824 kilowatts, while the power of the engines doubled. This change points to an increase of efficiency in operation. Arc dynamos went out after 1902, and since that year street lighting has been done with enclosed arc, besides the incandescent lamps. Coal consumption increased from 667 tons during the year ending June 30, 1896, to 2,507 tons during the year ending with the corresponding day of 1904, but the income from sales of electric energy went up from $5,946.88 in the earlier year to $48,507.07 in the later. The income per ton of coal consumed was thus $8.91 for 1896 and $19.34 for 1904, or 2.1 times as much in the later as in the earlier year. Figures for the series of years follow:

Year.	Tons of Coal.	Dollars of Electric Income.	Dollars Income per Ton.
1896....	667	5,946.88	8.91
1897....	441	7,494.77	16.99
1898....	763	10,905.75	14.29
1899....	1,328	18,311.05	13.78
1900....	1,507	24,537.89	16.28
1901....	2,054	30,865.10	15.02
1902....	2,264	34,835.99	15.38
1903....	2,916	42,395.07	14.53
1904....	2,507	48,507.07	19.34

This remarkable rise of electric income per ton of coal burned was brought about by increasing efficiency of operation, in spite of falling average rates for electric service. In 1896 the meter rate for incandescent lighting was twenty-five cents per kilowatt-hour and the flat rate was ninety cents per lamp per month. Commercial arc lighting with open lamps was charged for at the rate of five cents per inch of carbon burned. A discount of twenty per cent was allowed in the following year on bills for sixteen kilowatt-hours or over, at the above meter rate, and the flat rate for incandescent lighting was made fifty cents to $1.50 per lamp per month. These rates for commercial arc and incandescent lighting remained in force until 1901, when the net rate for incandescent lamps in stores was reduced to fifteen cents per kilowatt-hour. In the following year the maximum meter rate for incandescent lighting was lowered to twenty cents per kilowatt-hour, the discount of twenty per cent on monthly bills of sixteen kilowatts was made to apply only on 1,600 kilowatt-hours or over, the net rate of fifteen cents per kilowatt-hour for lamps in stores was retained and the net rate for lighting was fixed at ten cents per kilowatt-hour to customers using electric power for motors. Flat rates for incandescent lighting were put at one dollar per month for a single lamp and at ninety cents each for three lamps or more in 1903, and for arc lamps the flat rates were fixed at $6 and $7 per enclosed arc taking 6.6 amperes and $4.50 per arc taking four amperes per month. Since 1898 the commercial rate for open arc lamps, while five cents per inch of carbon burned in stores, had been eight cents per inch of carbon in factories. In 1903, also, the net meter rate for incandescent lighting every night, in stores, was lowered to ten cents per kilowatt-hour, but remained at fifteen cents for store lighting on only three nights per week. The year of 1904 saw no change in these several lighting rates. In 1896 the rate was $75 per year for each 1,200 candle-power arc street lamp on half-night service, and in 1904 this same rate was in force. Incandescent street lamps were also in use at the later date, the rate for those of thirty-two candle-power being $21 and for those of sixty-four candles $40 per year. In the year ending June 30, 1905, the maximum meter rate for electric energy used in motors at Attleboro was ten cents per kilowatt-hour, and varying discounts lowered this rate to as little as two and one-quarter cents per kilowatt-hour for large consumers. The introduction of the twenty per cent discount on monthly bills for sixteen kilowatts or over was probably a main factor in the increase of incandescent lighting in 1897, as was also the flat rate of fifty cents per lamp per month.

So, again, the rise of the connected load of incandescent lamps from 1,920, at the middle of 1899, to 10,000, in 1902, was probably due in large part to the net rate of fifteen cents per kilowatt-hour for stores and ten cents for factories and others using electric power, and to the reduction of the maximum meter rate from twenty-five to twenty cents per kilowatt-hour. Under these changes the number of users of incandescent lamps increased from 108, in 1900, to 279, in 1904. For the year ending June 30, 1905, the income from sales of electric energy was $53,170.19, and of this amount $22,379.79, or forty-two per cent, was for service to motors. Probably no other electrical supply system in the state derives so large a part of its income from a motor load.

The owner of the above notable system is the Attleboro Steam and Electric Company.

The Coal-Handling Plant of the London Metropolitan Electric Supply Station.

By Frank C. Perkins.

ONE of the most interesting electric plants in England is that of the Metropolitan Electric Supply Company, Ltd., in London, located at Acton Lane, N. W. This station has a most thoroughly up-to-date coal-handling plant, some features of which are shown in the accompanying illustrations.

The coal-handling plant was installed by Messrs. E. Bennis & Company, Limited, of Larden. It handles the coal at the rate of from sixty to eighty tons per hour and conveys it from the trucks to the furnaces. The contents of the loaded wagon or coal truck is turned over bodily in the hopper built to receive them and passed thence into the conveyor. One of the most novel features of this system of conveying is that it entirely does away with any form of bucket elevator, the whole of the fuel being elevated and conveyed with the "Bennis" type of U link chain conveyor.

There are two main lines of railway, opposite the boiler house, and a large coal-receiving bunker of seventy tons capacity has been built below the coaling lines. Immediately over the top of this bunker are mounted two of the "Bennis" patent rotary side-truck tippers, which enable the trucks to be run on the table of the revolving tipplers. Each tippler has a diameter of eighteen feet, permitting the engine to pass right through. The wagon is fastened in the tippler by booms which, when tightened up, perfectly secure the wagon in the tippler, the boom being provided with a strong compensating mechanism to take up any shock. This special feature of the tippler ensures that the truck is held down securely so that it can not move. The attendant, through a switch, sets a five-horse-power electric motor in operation, which rotates the tippler containing the truck, and delivers the fuel into the receiving hopper to be taken away by the conveyor. One specially interesting point to be noticed in the design of this tippler is that by its complete revolution it saves trimming, while clearing every ounce of coal. It rests on a series of

Coal Conveyer and Storage, Metropolitan Station, London, England.

rollers, one side being actuated by a reversible electric motor, and each tippler is capable of emptying 100 tons of coal per hour.

It is stated that the tippler rings are so proportioned that their centres coincide with the centre of gravity of the truck in end elevation. The advantage of this, it is claimed, is that little power is required in working the tippler.

The system of conveying consists of a series of chains in specially constructed troughs. The coal is conveyed through shoots with adjustable cutoff slides. The chain is placed immediately beneath the coal-receiving bunker. The cross conveyor partly elevates the fuel and delivers it on to the main inclined elevator conveyor which runs at an angle of thirty degrees, elevating its load through a height of forty feet, and delivers it into the main distributing conveyor running the full length of the overhead storage bunkers. The bottom of the distributing conveyor is fitted with openings and cutoff slides at intervals of three feet, which enables the fuel to be delivered at any point in the length of the bunker. Each section of the conveyor is used for driving a separate motor through substantial spur-wheel reduction gear. The conveyor consists of a series of chains working in cast-iron troughs which draw the coal from one point to another, delivering it eventually to the particular hoppers required by a system of slide doors. The elevator conveyor is sheltered from the weather by galvanized iron sheeting.

The power required for this system of conveyors is as low as twenty-five horsepower, and the capacity of the conveyor is from sixty to eighty tons per hour from the receiving hopper to the coal bunkers.

The trough in which the U shaped chains run is five-eighths-inch thick, fifteen inches wide and eight inches deep, and the chain itself consists of a series of U shaped links made out of two and one-quarter-inch by one-half-inch flats formed into links of twelve-inch pitch and secured at the joints by special seven-eighths-inch rivets and washers. The links are made of Siemens-Martin acid steel of a tensile strength from twenty-eight to thirty-two tons to the square inch, with an elongation of twenty per cent in eight inches.

Coal-Car Turning Device at the Metropolitan Electric Station, London, England.

In this plant the length of cross conveyor under the tippler is thirty-eight feet and the length of incline conveyor is 106 feet, while the length of bunker conveyor is 395 feet, giving a combined length of 539 feet.

It is maintained that the saving effected over the old system by the installation of this coal-handling plant from trucks to bunkers is as high as ninety per cent.

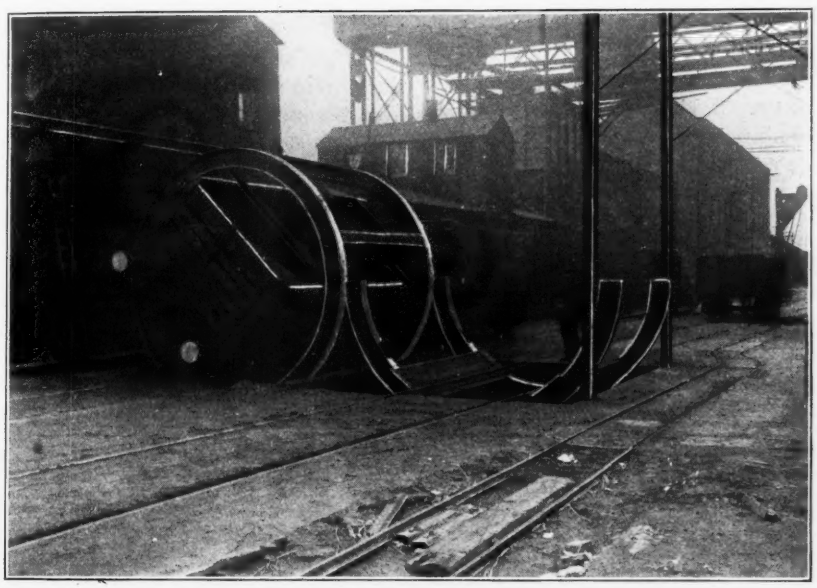
The automatic mechanical stokers used are of the "Bennis" type of machine stoker

fitted with pneumatic gear and self-cleaning compressed-air furnace, which is held to be an efficient and simple machine for feeding coal into the boilers and other furnaces. It is claimed that this machine stoker is able to do the stoking cheaper, and more evenly, producing a steady uniform fire all day with less coal and without interruptions for the supply of green coal and consequent variation of temperature than by hand stoking.

BOOK REVIEW.

"Electric Wiring, Diagrams and Switchboards." Newton Harrison. New York. Norman W. Henley Publishing Company. Cloth. 272 pages. 5½ by 7½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.50.

The author of this book has endeavored to give the electrical artisan a practical treatise on electric wiring, the construction of switchboards and other related subjects. He very properly discusses first the underlying principles, pointing out that the foundation of all this work is Ohm's law. He then discusses copper wire, its properties and use. Although intended primarily for building wiring, the book deals briefly with the principles of transmission and the types of electrical machinery employed. The methods of laying out and wiring switchboards are explained, boards of all types being described. Wiring diagrams are given for simple isolated plant boards, three-wire lighting boards for series systems, railway switchboards and switchboards for electrolytic purposes. The book concludes with a brief discussion of the principles of alternating currents and methods of computing wiring for such systems. In general, the discussions are clear and to the point, and there is a commendable avoidance of mathematical equations. At some points, however, the writing is not altogether clear, and there are, unfortunately, a number of mistakes in certain of the diagrams which, while not of much importance, may prove confusing to the beginner.



COAL CAR BEGINNING TO TURN, METROPOLITAN STATION, LONDON, ENGLAND.

THE TESTING OF TRANSFORMERS AND TRANSFORMER IRON.[1]

BY D. K. MORRIS AND G. A. LISTER.

When the primary winding of a transformer is excited from a constant pressure supply, the secondary voltage varies with the load by an amount depending upon the copper drop in the two windings and upon the leakage flux. The resultant of these two voltages (the combined copper drop and the leakage voltage) is that which must be impressed on one of the windings in order that a current may flow when there is no external resistance in the secondary circuit. It is the "short-circuit" voltage, each component of which, and consequently the whole, is proportional to the current. A right-angled triangle can be constructed, whose sides represent the magnitude and phase of the respective voltages. We have called this triangle the characteristic triangle of the transformer.

In Fig. 1, AC represents the combined resultant copper drop, BC the voltage due to the leakage flux and AB the resultant voltage. In the case of a unity power-factor load the drop is that due to copper resistance only, the effect of the leakage being to cause a phase difference between the primary and secondary volts without actual reduction of the secondary terminal volts. If the secondary current lag, then the triangle will take up the position AB′C′, in which AC′ lags in phase with respect to the secondary volts, and B′C′ the leakage volts. It will be seen that the latter now has a component in phase with the secondary voltage and tending to reduce it, the actual drop at the secondary terminals being given by AD′. Similarly, in the case of a leading current, the drop is given by AD″.

It is convenient to draw the triangle so that the scale of AC represent the copper drop for full-load current. A scale of current is then marked on AB. Current

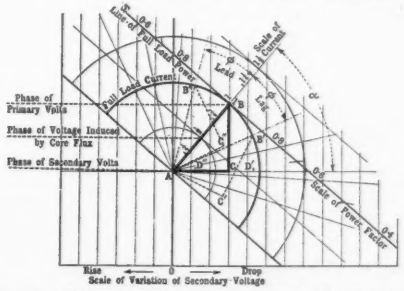


FIG. 1.—TRANSFORMER REGULATION DIAGRAM.

circles and load lines are now drawn; and also lines radiating from A to represent the various positions of the line AB for different power-factors. The drop in the secondary voltage which will be caused by any current or load having any power-factor, lag or lead, is then immediately obtained from the figure by inspection.

Theoretically it is not correct to project the point B on to the base line, for the primary and secondary volts are not quite in phase. But in commercial transformers with moderate leakage the error is quite negligible.

The characteristic triangle of transformers is usually obtained by means of the short-circuit test due to Kapp, or if two similar transformers are used, the Sumpner method with auxiliary testing transformer can be employed.

In view, however, of certain objections to the latter, the authors propose the standard transformer test described below. The connections and method of carrying out the test are given in relation to a three-phase supply, but it can be equally well applied to a two-phase supply.

The connections are shown in Fig. 2. One of the supply points is joined through the wattmeter W_1 to the middle point of the secondary winding of the auxiliary transformer. The terminal pressure of one transformer is raised and the other lowered, the average flux density of the two transformers thus remaining normal.

The primary winding of the auxiliary transformer is connected to the supply as shown through a main-current regulator. By moving the adjustable contact of the regulator the phase of the impressed short-circuit voltage can be varied through sixty degrees.

The essential instruments are the watt-

[1] Abstract of a paper read recently before the Birmingham section of the Institution of Electrical Engineers of Great Britain.

meter W_1 measuring the iron losses, the wattmeter W_2 measuring the copper losses, and a variable range voltmeter for determining the supply pressure and the voltage of the auxiliary transformer. These instruments are sufficient to determine all the information necessary to carry out the standard tests. For some time past the authors have used a device in connection with these and other alternate-current tests

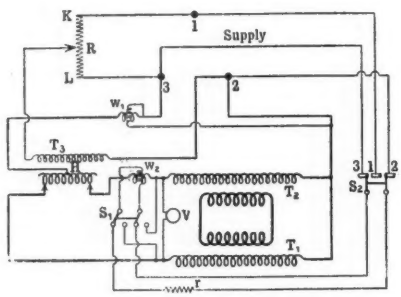


FIG. 2.—CONNECTORS FOR DIFFERENTIAL TRANSFORMER TESTS.

T_1, T_2. Two similar transformers under test.
T_3. Auxiliary testing transformer.
w_1. Wattmeter reading iron losses of transformers T_1 and T_2.
w_2. Wattmeter reading copper losses of transformers T_1 and T_2, also used to determine current and phase angle by three-point wattmeter method.
V. Low-reading voltmeter for measuring secondary voltage of auxiliary transformer.
R. Main current regulator for varying phase angle of current.
r. Resistance for volt circuit of wattmeter w_2.
S_1. Two-way double-pole volt switch.
S_2. Three-phase volt switch.

which renders an ammeter unnecessary, and which also enables the power-factor of the current to be accurately determined. It is applicable where the test is carried out on a two or three-phase supply, and may conveniently be called the three-point wattmeter method.

Let 1, 2 and 3 be the supply points of a three-phase delta-connected system. Let the voltages be e_1, e_2 and e_3 and let θ_3 and θ_2 be the phase angles between e_1, e_2 and between e_1, e_3, respectively. A wattmeter is connected in the phase 3.2, and

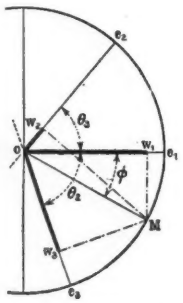


FIG. 3.—THREE-POINT WATTMETER METHOD.

a voltmeter is available for accurately measuring the voltages e_1, e_2 and e_3. A throw-over switch is arranged so that the volt coil of the wattmeter can be connected in turn to the phases 3.2, 3.1 and 1.2. Let the wattmeter readings be w'_1, w'_2 and w'_3, respectively. If the three voltages are not equal, the wattmeter readings should be corrected to the amount which they would have read had all the voltages been equal to e_1. Let these corrected readings be w_1, w_2 and w_3. Fig. 3 shows graphically these readings of the wattmeter when the current lags behind the voltage e_1 by an angle ϕ, and where the line OM represents to scale the product of the voltage e_1 and the current i.

It can be shown that

$$\tan\phi = \frac{1}{\tan\theta_3} - \frac{w_2}{w_1 \sin\theta_3} = \frac{1}{\tan\theta_2} - \frac{w_3}{w_1 \sin\theta_2}.$$

The in-phase component of current is, of course, w_1/e_1; and having determined the angle ϕ, the out-of-phase component is given by $w_1/e_1 \tan\phi$ and the total current by $i = w_1/e_1 \cos\phi$.

When all three voltages are equal, and $\theta_1 = \theta_2 = \theta_3 = 60$ degrees, as will usually be the case, the out-of-phase component becomes $w_1/\mathrm{E} \tan\phi$ and the in-phase component w_1/E. The current itself may be determined without reference to the phase angle ϕ.

$$i = \frac{1}{\mathrm{E}}\sqrt{w_1^2 + \frac{(2w_2 - w_1)^2}{3}},$$

and the out-of-phase component $=$

$$\frac{2w_2 - w_1}{\sqrt{3}\,\mathrm{E}}.$$

The following detailed descriptions show how the various qualities of a transformer may be determined.

(*a*) Core Losses—The iron losses of the two transformers are read directly on the wattmeter W_1. This wattmeter only carries the magnetizing current of the two transformers T_1 and T_2. The copper watts of the whole system and the iron watts of T_3 do not in any way affect the reading of W_1.

In most cases it is sufficient to note the iron watts at the normal voltage and frequency. When it is desired to separate the losses between hysteresis and eddy currents, the tests may be done in two ways.

1. Variable Frequency Tests—This is done by keeping the ratio of volts to frequency constant after the manner of the Kapp-Housman test on direct-current generators. The watts per cycle are then plotted against the frequency and the losses readily separated. It is important to take the frequency as low as possible in order to be able to project back to the point which will give the static hysteresis loss.

2. Constant Frequency Test—It is sometimes inconvenient to arrange for a variation of the frequency of the supply, and in such cases the following test is recommended as one which will give rapidly a good approximate value of the relative amount of hysteresis and eddy current loss.

Method of Total Index—The test consists in varying the voltage while the frequency remains constant. The iron loss measured by the wattmeter may be expressed $w = a\mathrm{E}^x + b\mathrm{E}^2$, where the first term represents hysteresis loss and the second the eddy loss. The total loss, however, may not inaccurately be given as $w = c\mathrm{E}^y$, where y and c are readily determined from two readings by the use of logarithms. Combining the above, we find that $c = a\mathrm{E}^{x-y} + b\mathrm{E}^{2-y}$ that is $a\mathrm{E}^{x-y}$ must decrease as fast as $b\mathrm{E}^{2-y}$ increases. On the assumption that x is constant, therefore, it will be found that

$$\frac{w_h}{w_e} = \frac{2-y}{y-x}.$$

All the more recent determinations of x in the range covering transformer working flux densities have given the value 1.5 and not 1.6 for this index, and we have also arrived at figures approximating to 1.50 for transformer cores working at flux densities ranging, say, from 2,000 to 6,000 lines per square centimetre.

To separate the losses, then, it is merely necessary to take two wattmeter readings, w_1 and w_2 at voltage E_1 and E_2, near the required value, and find the value of y as follows:

$$y = \frac{\log w_1/w_2}{\log \mathrm{E}_1/\mathrm{E}_2}.$$

Then, taking 1.5 as the value of x, the ratio

$$\frac{\text{hysteresis loss}}{\text{eddy loss}} = \frac{2-y}{y-1.50}$$

gives the required information.

(*b*) Copper Losses—The combined copper losses in the primary and secondary windings of the two transformers are given by the reading of the wattmeter W_2. The connections are such that the magnetizing current required by the system does not pass through this instrument.

If the volt leads are connected to the actual terminals of the transformers, and there are no instruments or switches in the circuit consisting of the secondary windings, the wattmeter reading gives a true measure of the copper loss in the two transformers under test. Attention should, however, be paid to the effect of the current taken by the volt coils.

(*c*) Efficiency—Since the efficiency of a transformer depends solely on the voltage and frequency of supply, and upon the current in the windings, it is not necessary

to adjust the power-factor. The product of the voltage e_1 and the current i may be taken as the mean circulating power, the current being conveniently measured by the three-point wattmeter method. The losses having been determined by the wattmeter readings, the efficiency of one transformer is given by

$$\eta = \sqrt{\frac{\text{circulating power}}{\text{circulating power} + \text{losses}}}.$$

It is, however, preferable to adjust the power-factor to unity and connect the volt coils of the wattmeter to the supply points 2.3. The instrument then reads the mean power directly and the determination of the efficiency is thus simplified.

(*d*) Heating—When testing a transformer it is important to determine the final temperature which will be reached as the result of a continued application of the rated full load. An approximate idea of this temperature may be obtained by observing during the test the readings of thermometers placed in suitable positions in the transformer. When these indicate that final conditions have been reached, the resistance can be determined quite easily from the wattmeter and voltmeter readings by the three-point method already described. The authors have found this quite the most satisfactory way of determining the temperature rise by resistance measurement.

(*e*) Regulation on all Power-Factors—It will usually be sufficient to determine the characteristic triangle of the transformers, and to draw the diagram giving the required regulation curves in the manner previously described. The triangle is best determined by adjusting the current to its full-load value and the power-factor to unity, and observing the low voltage impressed on the primary circuit and the reading of the wattmeter W_2. This latter reading divided by the current will give the copper voltage. The leakage voltage is given by

$$\sqrt{(\text{short-circuit volts})^2 - (\text{copper volts})^2}.$$

The triangle thus obtained is for two transformers, half the values giving the characteristic triangle. It may be noted that the difference in the voltages of T_1 and T_2 is practically the double copper voltage when the power-factor of the circuit is unity, and if the power-factor be adjusted till the current is exactly ninety degrees, out of phase, then this difference is a direct measure of the leakage volts. On any power-factor this difference will, of course, give the regulation of the transformer.

HYSTERESIS BY SLOW CYCLIC CHANGE.

The two methods already given for arriving at the loss through hysteresis alone in the transformer core are based, the one on the possibility of varying the frequency, and the other upon a knowledge of the index x. To determine the latter and generally to eliminate all the effects of rapid magnetic variation, and arrive at the true hysteresis loss is, however, important. Ballistic methods of measuring hysteresis are impracticable, on account of the mass of iron to be magnetized. There is, however, one method available, which was proposed by C. F. Scott. It is the method of constant induced voltage. The primary current supplied from a low-voltage direct-current source is varied from a negative to a similar positive value at such a rate as to keep the small secondary induced voltage constant throughout the whole change. This method, which is at once easy to carry out, expeditious and accurate, does not appear to have attracted the attention it deserves. The present authors have developed this method, and show here how by its means the hysteresis not only of large transformers, but also of small samples of transformers, iron, or rings of cast steel, may be tested for permeability and hysteresis.

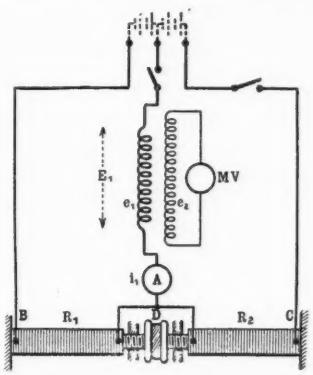


FIG. 4.—CONNECTIONS FOR MAGNETIC TEST.

To find the hysteresis loss in a transformer core working at a given flux density, the following connections are suitable: in the first place, a rheostatic device is required which will permit of a continuous adjustment of the small magnetizing current from the value necessary to give the required flux density right down through the zero value to the negative maximum value. To effect this a three-wire low-voltage source of current is convenient. Two light carbon rheostats are mounted back to back with their handles bound together so that when the one is tightened the other is loosened (Fig. 4). They are joined in series across the outer supply points, while the central point is led through the transformer winding to the middle supply terminal. When the rheostats are equally tight, then no current flows through the transformer. If the rheostat handle is worked so as to tighten R_1 the potential of the junction point D will tend to coincide with that of B, so that a PD will be set up across the terminals of the winding; and the current in it may then be continuously adjusted down through zero to a negative maximum.

The rate of supply of energy of the primary winding is $E_1 i_1 = e_1 i_1 + i_1 r^2$ watts.

The energy change during any given period is

$$f E_1 i_1 d t = f e_1 i_1 d t + f i_1^2 r_1 d t.$$

But e_1 is kept constant $= Ke_2$ where K = ratio of transformation in transformer. Hence magnetic energy $Ke_2 f i_1 dt$. Plot i_1 against t for rising and falling currents. Its area in ergs divided by the volume of the iron in the core in cubic centimetres is the hysteresis loss in ergs per cubic centimetre per cycle.

It is thus merely necessary to note time readings of the ammeter or to use a recording instrument to obtain at once the hysteresis loss.

Application of Constant Induced Voltage Method to Small Samples—The arrangement shown in Fig. 4 is used, the carbon rheostats employed having plates three and one-half inches square. The primary winding of the transformers is replaced by a single straight length of 19/16 cable. The sample consists of a strip one inch or two inches wide, and, say, four feet long, cut from the transformer sheet and rolled up tightly on a wooden former turned to a diameter of, say, five centimetres. A wide groove is left in the former in which the secondary, consisting of a flat coil designed to suit the indicating instrument, is placed. The sample is passed through this as it is rolled up, and the whole is then slipped on to the straight conductor. The terminals of the secondary are either joined straight on to a sensitive indicating millivoltmeter or an opposing electromotive force is employed as in the transformer set. "Air lines" can be compensated for by the use of a few turns of wire suitably placed near the straight conductor. Any required number of curves of current as it varies with time are then taken by the method of constant induced voltage; and, as the dimensions of the magnetic circuit are known, the curves can, if required, be reduced to B—H curves, and all the necessary magnetic data obtained.

The flux densities occurring in transformers are caused by fields not exceeding two to four C. G. S. units. The magnetic

field along the circumference of a circle of a centimetres radius, through whose centre a conductor carrying i amperes is passed is $0.2\ i/a$. If $a = 2.5$ centimetres, then for $H = 2$ and $H = 4$, $i = 25$ and 50 amperes. In laboratories, where the low-voltage supply need not come from portable cells, these currents are readily obtainable.

Thus a sample of iron can be tested in the form of a ring without being wound at all. It has merely to be rolled up on the former. And the method of constant induced voltage is equivalent to a ballistic test, the magnetic circuit of the sample being closed. Considerable experience with this method of testing samples during the last few months has shown clearly to the authors its great superiority for ordinary magnetic testing. It is not difficult to obtain the permeability and hysteresis curves, and the Steinmetz coefficient and index for a sample in the course of an hour; a result which can not be obtained by the ordinary ballistic method. Since the method involves only a slow magnetic process, samples of cast steel in the form of rings, which can not be dealt with ballistically, may be tested for magnetic quality.

In the *Philosophical Magazine* for April, Professor Alfred W. Porter discusses the inversion points of the Joule-Kelvin effect for a fluid passing through a porous plug. The paper is a simple and straightforward deduction from the laws of thermodynamics. The condition that an infinitesimal difference of pressure on the two sides of the plug should give rise to no "cooling" or "heating effects" is given by the equation $Td/vdT - v = 0$, and when the pressure-volume-temperature equation is given, this condition determines a curve in the p,T or v,T diagram formed by the inversion points. Professor Porter's paper is mainly taken up with examining the form of this curve corresponding to various assumed equations of state, such as that of van der Waals or Dieterici. From the form of the curves it is shown that in general two inversion temperatures exist for the same pressure, between certain limits of pressure; in the case of van der Waals's equation, the maximum limit is nine times the critical pressure. Finally, the author points out that the experimental study of these inversion curves affords a very valuable method of testing the relative validity of different equations of state. Theoretically also a knowledge of the inversion curve and the equation of state referred to any given thermometric scale afford sufficient data to determine the relation between that scale and the absolute temperature.—*Nature.*

HIGH EFFICIENCY INCANDESCENT LAMPS FOR STREET LIGHTING.[1]

BY FRANCIS W. WILLCOX.

Incandescent lamps used in series form a simple and efficient method of lighting streets in small towns and suburban localities, and in fact all places where the result is to be obtained at a minimum expense, or where the conditions do not permit the use of high candle-power lamps of the arc type to obtain the desired illumination.

Incandescent lamps have obvious advantages in street lighting work, as they can be made in low candle-power sizes and distributed at frequent intervals, thus securing a very uniform distribution of light as compared to the massing of greater total candle-power at greater distances apart necessary with high candle-power illuminants. Until the last three or four years the use of series lamps for street lighting has not been altogether satisfactory by reason

1. Of the lack of efficient and reliable devices for the automatic regulation of current.

2. Of unsatisfactory apparatus for automatically cutting out the lamp on breakage of filament, and

3. Unsatisfactory and inefficient incandescent lamp in the candle-powers, ampere and voltage ranges required for this class of service.

As regards the regulating apparatus the various devices employed for this service are familiar to all central station managers and need not be described here. Sufficient to say that the bank board, the shunt box, the hand-control reactive coil and similar devices have given way to the constant current transformer. This excellent device automatically ensures such a uniform and well-regulated service that satisfactory life can be obtained from lamps of relatively much higher efficiency than could be previously used. This improved regulating apparatus has, therefore, assisted to definitely establish street series incandescent lighting on a satisfactory basis.

Similarly in the socket cutout a material improvement has been made by removing the cutout from the base of the lamp to the socket and the adoption of higher line voltages has ensured a more certain action of the cutout film by which a burned-out lamp is short-circuited and the current maintained uninterrupted.

The incandescent lamp, as used for street lighting, has not in the past been altogether satisfactory, due to a number of conditions, the lamp being a difficult one to manufacture owing to the heavy currents employed. In justice to these previous lamps, however, it should be noted that their results would have been materially better had they been used with modern constant current transformers and that, as bad as the lamps appeared to be, most of the troubles were caused by the bad service conditions.

In recent years material improvements have been made in the quality of street series lamps so as to enable them to withstand the rigors of the service, and the price of the lamps has been greatly reduced, so that the economy of series incandescent lamp service has been materially improved from the lamp standpoint.

THE NEW HIGH EFFICIENCY SERIES LAMP.

The most remarkable improvement, however, has been achieved in the past year with the discovery and development of the new metallized or "Gem" filament and its application to street series lamps. The benefits of the metallizing process apply particularly to lamps of the street series types, which are in general lamps with sufficient thickness and size of filament to realize the full measure of improvement which this process can give.

In the case of the usual types of street series lamps this improvement appears to be about thirty per cent in efficiency. This means that the metallized filament street series lamps can be made of an efficiency of 2.5 watts per candle equal in life for any given candle-power to that of the present 3.5 watts per candle. This is the material gain of one watt per candle and we can probably appreciate it more fully by reference to curves and accompanying diagrams (Fig. 1).

The curves show the life performance taken to about seventy-five per cent of initial candle-power at various efficiencies for the new and old filament. In the case of street series lamps the improvement in life values is graphically portrayed. The improvement secured by the metallized filament appears to be largely due to reduction in blackening. As is well known the change in candle-power of incandescent lamps is due to two factors: change in resistance of filament and blackening of bulb.

In the ordinary carbon filament the proportion of the loss of light due to these two causes is as follows: due to blackening, fifty-five per cent of the loss; due to change in resistance, forty-five per cent of the loss.

On the new metallized filament it is estimated that this loss is proportioned as follows: due to blackening, twenty per

[1] Paper read before the Illuminating Engineering Society, New York City, May 11, slightly abridged.

cent; due to change in resistance, about eighty per cent.

The change of candle-power of a lamp for series work due to change in resistance should theoretically be corrected by the automatic increase of voltage by which the current is maintained constant through filament.

On this basis the new series lamp (with

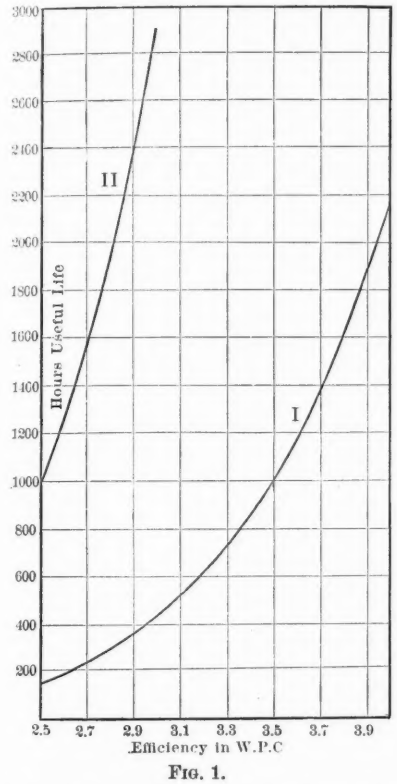


FIG. 1.

Life and candle-power curves of (I) ordinary carbon filament, (II) new "GEM" filament street series lamps in range of 3.5 amperes (or less), 25 and 30 candle-power. Values taken to 75 per cent of initial candle-power.

eighty per cent of its initial candle-power loss due to change in resistance) should develop more than the present lamp, the ideal characteristic of a rising life and candle-power curve. To illustrate this point I will call to attention Fig. 2. The rising candle-power curve is actually given with lamps of one to two amperes, but for some reason does not develop with lamps of higher amperages.

Street series lamps, life and candle-power curves, however, show a tendency to hold up; for with a given life to eighty per cent of the initial candle-power and the life to seventy or seventy-five per cent is four times as long. This suggests the use of a lower percentage limit for useful candle-power—seventy per cent to seventy-five per cent instead of the eighty per cent value used for multiple lamps.

In exploiting the new "Gem" filament street series lamps the question arose as to what efficiency it was desirable to adopt for this lamp for general conditions of central station service. At the present time there are two efficiencies for street series lamps, namely, 3.5 and four watts per candle. The four watts per candle efficiency is a relic of old conditions and poor regulation, and with the use of the modern constant current transformer has been replaced largely by lamps of 3.5 watts per candle efficiency.

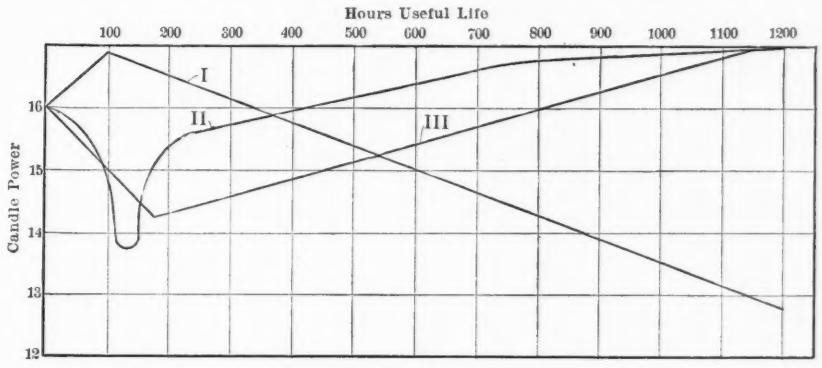


FIG. 2.

Diagram illustrating difference in life and candle-power curves of lamps when burned, (1) at constant voltage, and (2) at constant amperes. (I) Life and candle-power curve of ordinary multiple incandescent lamp, 3.5 watts per candle efficiency. (II) Calculated curve of performance at constant amperes, calculated from curve I. (III) Actual curve of life and candle-power performance at constant amperes, from average of nine lamps on test of 25 candle-power, 1.75 amperes, 3.5 watts per candle efficiency.

As far as conditions of service are concerned with apparatus available which will ensure uniform regulating conditions, and such apparatus is available, but one efficiency would seem necessary for series lamps. This class of central station service varies but little, as operating costs run about the same therefor, and the service is uniformly paid for on the basis of lamp year or lamp month. It, therefore, seemed that the new "Gem" filament lamp should be made and supplied in but one efficiency, namely, that efficiency which would give central station companies the minimum operating cost for this class of service, covering cost of power delivered at the lamp and the cost of the lamp renewals.

Assuming the twenty-five-candle-power lamp as a standard in the ranges of 5.5 amperes and below, there are in round figures practically three costs of lamp to consider, namely, thirty, forty and fifty cents.

Assuming further a cost per kilowatt-hour delivered at the lamp of one, two, three and four cents per kilowatt-hour, let us estimate the cost of light for an annual service of 4,000 hours for lamps of different efficiencies and plot the results as shown on the diagram in Fig. 3. The horizontal curves of this diagram represent the costs of lighting at different efficiencies covering lamp renewals and power at the rate shown. The three curves in each group arise from the three costs of lamps, thirty, forty and fifty cents for the different ampere ranges. You will notice that each of these curves has a minimum point; that is, a point where the sum of the power and lamp renewals at varying efficiencies is a minimum. From these points are drawn the vertical lines shown, which are lines indicating the efficiency for any given cost of power and cost of lamp that will secure the lowest cost of lighting service.

The writer understands that a safe figure for the cost of power delivered to lamp for this class of service, including all charges, fixed and operating, is between

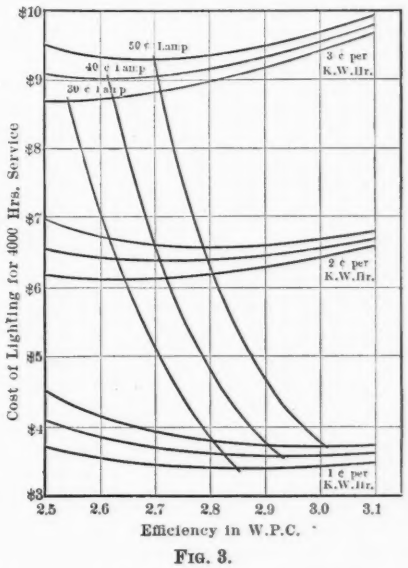


FIG. 3.

Curves showing efficiency of new "GEM" filament street series lamps (25 candle-power, 5.5 amperes and below), which have a minimum cost of lighting service, including cost of power (at the various rates shown, 1 cent, 2 cents, 3 cents) and lamp renewals at the three costs of lamp shown (30 cents, 40 cents, 50 cents). The diagram indicates the efficiency, giving the minimum cost for the average condition for the new lamp at 2.7 watts per candle. Cost shown is for a year's service, 4,000 hours.

two and three cents per kilowatt-hour. On this basis it is seen that the efficiency for the minimum cost, assuming an average price of forty cents per lamp, is about 2.7 watts per candle. This efficiency has been accordingly adopted as the standard for the new filament street series lamps with hopes that later still higher efficiencies may be supplied.

The conditions of street series lighting service are different from those of the ordinary consumer's service and greater emphasis must be laid on the life of the lamp. Further, owing to the fact that light is sold by the lamp month or lamp year, the cost to central station is the correct basis for determining the efficiency of these lamps, and, therefore, a materially longer life is required than in the regular lighting service with consumers. For this and other reasons it was decided to adopt the 2.7 watts per candle efficiency for the new lamp, although these new lamps could be supplied at 2.5 watts per candle with a life equal to that of the present 3.5 watts per candle lamp. At the efficiency adopted, 2.7, the life of the lamps will be about fifty per cent longer than that of the present 3.5 watts lamps, and about an equal amount less than that of the present four watts per candle lamp; that is, the life will be a mean of the life values of the present 3.5 and four watts per candle lamps of the same candle-power and ampere range.

To determine the value of these new lamps in comparison with the present lamps, let us estimate the annual kilowatt-hours saved therewith.

Taking, now, the twenty-five-candle-lamp as a basis, it gives a saving between the present and new lamp for the same life (1,000 hours) of one watt per candle, or twenty-five watts. The actual hours of use for series lamps approximate 4,000 hours per year, giving us 100 kilowatt-hours saving per year per socket; 4,000 hours represent four lamp renewals per year, so that the 100 kilowatt-hour total annual saving per socket is twenty-five kilowatt-hours saving per lamp. This is worth at two cents total cost per kilowatt-hour fifty cents, or at one cent total cost per kilowatt-hour twenty-five cents, which represents the additional value of the new series lamp for this candle-power. The increase in price for this candle-power of lamp is less than ten cents.

In street lighting service central stations sell by the lamp year, so that the new series lamp would not reduce the income of a company (as it would where light is sold by meter on watt-hour basis). Central stations would, therefore, receive the full benefit of the savings of the new lamp.

Its effect on income would be something like the following:

Rates for street lighting are generally about $1 per candle-power per year; for twenty-five-candle-power lamp is paid per year $24. The income, therefore, for the same investment in station apparatus gives 100 old lamps at $24 = $2,400; 140 new lamps at $24 = $3,360 — net gain, = $960; expense lamp renewals, three and one-half amperes, old lamps at thirty-nine cents each, five renewals per year = $195; expense lamp renewals, new lamps at seven cents added price, or forty-six cents each, $322; fixed charges on additional line equipment for forty additional new lamps, $30; total, $352 — $195 = $157.

Deducting this expense (difference of $157) from the difference between two net incomes above, we find that the new lamp gives an additional income of $803, or $8.03 per lamp per year.

With the introduction of new series lamp it is desirable for central station companies to eliminate many of the present variations in ampere ranges and candle-power sizes of lamps.

The accompanying table shows the various types of series street lamps supplied and the watts and voltages per lamp for the two efficiencies of the present lamp and the new high efficiency filament lamp.

TABLE I.

STREET SERIES LAMP DATA—VOLTS AND WATTS PER LAMP FOR VARIOUS EFFICIENCIES.

Ampere.	Candle-Power.	Present Series Lamps. 4 Watts per Candle Efficiency.		Present Series Lamps. 3.5 Watts per Candle Efficiency.		New GEM Filament Series Lamps. 2.7 Watts per Candle Efficiency.	
		Volts	Watts.	Volts.	Watts.	Volts.	Watts.
1.75	16	36.6	64	32.0	56.0	24.70	43.2
	20	45.7	80	40.0	70.0	30.9	54.0
	25	57.2	100	50.0	87.5	38.60	67.5
	30	68.6	120	60.0	105.0	46.3	81.0
	40	91.4	160	80.0	140.0	61.70	108.0
	50	114.2	200	100.0	175.0	77.20	135.0
3.0	20	26.7	80	23.3	70.0	18.0	54.0
	25	33.3	100	29.2	87.5	22.5	67.5
	30	40.0	120	35.0	105.0	27.0	81.0
	40	53.3	160	46.7	140.0	36.0	108.0
	50	66.7	200	58.3	75.0	45.0	135.0
3.5	20	22.8	80	20.0	70.0	15.43	54.0
	25	28.6	100	25.0	87.5	19.30	67.5
	30	34.0	120	30.0	105.0	23.14	81.0
	40	45.7	160	40.0	140.0	30.85	108.0
	50	57.2	200	50.0	175.0	38.5	135.0
	65	74.3	260	65.0	227.5	50.0	175.0
5.5	20	14.55	80	12.72	70.0	9.818	54.0
	25	18.18	100	15.91	87.5	12.27	67.5
	30	21.8	120	19.09	105.0	14.727	81.0
	40	29.09	100	25.45	140.0	19.636	108.0
	50	36.36	200	31.81	175.0	24.545	135.0
	65	47.27	260	41.36	227.5	31.909	175.5
	75	54.54	300	47.72	262.5	36.818	202.5
	100	72.72	400	63.53	350.0	49.09	270.0
	125	90.91	500	79.5	437.5	61.36	337.5
6.6	20	11.72	80	10.6	70.0	8.18	54.0
	25	15.15	100	13.26	87.5	10.23	67.5
	30	18.18	120	15.91	105.0	12.27	81.0
	40	24.24	160	21.21	140.0	16.36	108.0
	50	30.30	200	26.52	175.0	20.45	135.0
	65	39.39	260	34.47	227.5	26.59	175.5
	75	45.45	300	39.77	262.5	30.68	202.5
	100	60.61	400	53.03	350.0	40.91	270.0
	125	75.76	500	66.29	437.5	51.14	337.5
7.5	30	16.0	120	14.0	105.0	10.80	81.0
	40	21.3	160	18.66	140.0	14.40	108.0
	50	26.66	200	23.33	175.0	18.0	135.0
	65	34.666	260	30.3	227.5	23.3	175.5
	75	40.0	300	35.0	262.5	27.0	202.5
	100	53.3	400	46.7	350.0	36.0	270.0
	125	66.66	500	57.7	432.5	45.0	337.5
9.6	30	12.5	120	10.9	105.0	8.43	81.0
	40	16.66	160	14.6	140.0	11.25	108.0
	50	20.85	200	18.2	175.0	14.1	135.0
	65	27.1	260	23.7	227.5	18.3	175.5
	75	31.3	300	27.3	262.5	21.1	202.5
	100	41.7	400	36.5	350.0	28.1	270.0
	125	52.1	500	46.0	437.5	35.1	337.5

This table shows seven current ranges and six candle-power sizes for each, or forty-two kinds of lamps—altogether too many varieties—and I desire to offer some practical suggestions on the point.

CHOICE OF AMPERE RANGES.

Choice of ampere range is determined largely by the number of lamps of any given candle-power it is desired to run on one circuit. The higher the amperage the lower the voltage of lamp and, therefore, the greater the number of lamps that can be operated on a given circuit. The following table shows this number for the different candle-powers and the ampere ranges for different primary voltages of 1,100, 2,200, etc., up to 5,500 volts. With the present constant current transformers it is practicable to employ voltages of 5,500 volts and average conditions will permit the use of at least 3,500 volts. It is desirable to keep the voltage above 3,000 to ensure certainty of operation of the film cutouts in the lamp sockets.

The desirable number of lamps per circuit will vary according to conditions, but appears to be from 100 to 150 lamps. On this basis I have drawn in on table 2 a black line to separate the candle-power sizes, which for any given primary voltage will run 100 lamps per circuit. Taking 3,500 volts as an average primary voltage, this permits of the use of candle-powers for the different ranges given below.

By the use of 5,500 volts the range is extended to include twenty-five and thirty candle-power on 1.75 ampere range and all the candle-powers in the other ranges.

Assuming 3,500 to 5,500 volts as the average circuit voltage, the above analysis shows us that it would not be necessary to employ higher amperages than 5.5 with 3,500 volts, or higher amperages than 3.5, or preferably 1.75 amperes with 5,500 volts to obtain 100 lamps per circuit. The use of lamps above 5.5 amperes seems to be confined largely to circuits in which the lamps are used in series with arc lights. It is very desirable in point of quality of lamps to keep the amperage of circuits as low as possible, as it is difficult to make series lamps of satisfactory quality for higher amperages where the volts per lamp are low and where the difficulties of exhaustion are therefore materially multiplied. The 5.5 ampere ranges of any candle-power give better life service than the 6.6 ampere lamps of the same candle-power. Likewise the 3.5 ampere lamps are better than the 5.5 ampere and the 1.75 ampere are better than the 3.5 ampere. Assuming candle-powers of fifty and less the best quality appears to be obtained in the ampere ranges between one and three amperes.

It is to be sincerely hoped that the trend of practice will be to abandon the use of the higher ampere ranges, such as 6.5, 7.5 and 9.5 amperes.

DESIRABLE CANDLE-POWERS.

What determines the desirable candle-power for street lighting service? This considers not only the size of unit in can-

TABLE II.

TABLE SHOWING NUMBER OF NEW GEM SERIES LAMPS (2.7 W. P. C.) THAT CAN BE OPERATED ON A CIRCUIT WITH VARIOUS LINE VOLTAGES.

Ampere.	C. P.	Volts.	Number of Lamps per Circuit for Primary Line Voltage of 1100 (1000)	2200 (2000)	3500 (3200)	4400 (4000)	5500 (5000)
1.75	16	21.70	40.	81.	129.0	162.	202.
	20	30.90	32.	65.	107.	129.	162.
	25	38.60	26.	52.	83.	103.	129.
	30	46.3	21.	43.	69.	86.	108.
	40	61.70	16.	32.	52.	65.	81.0
	50	77.20	13.	26.	41.	52.	65.
3.0	20	18.0	55.	111.	178.	222.	278.
	25	22.5	44.	89.0	142.	178.	222.
	30	27.0	37.	74.	119.	148.	185.
	40	36.0	28.	55.	89.	111.	139.
	50	45.0	22.	44.	71.0	89.0	111.
3.5	20	15.43	64.	129.	206.	258.	323.
	25	19.30	52.	103.	166.	207.	259.
	30	23.14	43.	86.	138.	173.	16.
	40	30.85	32.	65.	104.	130.	162.
	50	38.5	26.	52.	83.	104.	130.
	65	50.0	20.	40.	64.	80.	100.
5.5	20	9.818	102.	204.	326.	407.	510.
	25	12.27	81.	163.	261.	326.	407.
	30	14.727	68.	135.	217.	271.	339.
	40	19.636	51.	102.	163.	203.	254.
	50	24.545	40.	81.	130.	163.	204.
	65	31.909	31.	63.	100.	125.	157.
	75	36.818	27.	54.3	87.	108.	135.
	100	49.09	20.	40.	65.	81.	102.
	125	61.36	16.	32.	52.	65.	81.
6.6	20	8.18	122.	244.	391.	488.	610.
	25	10.23	97.	195.	312.	390.	488.
	30	12.27	81.	163.	261.	326.	408.
	40	16.36	61.0	122.	195.	244.	306.
	50	20.45	49.	98.	156.	195.	244.
	65	26.59	37.	75.	120.	150.	188.
	75	30.68	32.	65.	104.	130.	163.
	100	40.91	24.	49.	78.	98.	122.
	125	51.14	19.	39.	62.	78.	98.
7.5	30	10.80	92.	185.	296.	370.	463.
	40	14.40	69.	139.	222.	278.	347.
	50	18.0	55.	111.	177.	222.	278.
	65	23.3	43.	86.	137.	171.	214.
	75	27.0	37.0	74.0	118.	148.	185.
	100	36.0	28.0	55.	89.	111.	139.
	125	45.0	22.	44.	70.	89.	111.
9.6	30	8.43	119.	237.	356.	474.	594.
	40	11.25	89.	177.	284.	356.	445.
	50	14.1	71.	142.	227.	284.	355.
	65	18.3	55.	109.	175.	218.	273.
	75	21.1	47.	95.	152.	189.	236.
	100	28.1	35.	71.	113.	142.	177.
	125	35.1	28.	57.	91.	114.	143.

Ampere Range.	
1.75	16 and 20 candle-power.
3.0	20, 25 and 30 candle-power.
3.5	20, 25, 30 and 40 candle-power.
5.5	20, 25, 30, 40, 50, and 60 candle-power.
6.6	20 to 75 candle-power, inclusive.
7.5	30 to 75 candle-power, inclusive.
9.6	30 to 75 candle-power, inclusive.

dle-power, but the distribution therefrom. The desirable candle-power appears also to be fixed in a large measure by conditions of competition. Competition for this class of service is principally against the Welsbach gas lamps, and it has been found by tests that the thirty-candle-power street series incandescent lamp will, under average conditions, give illumination equivalent to the ordinary Welsbach street lamp. In practice the majority of electric incandescent street series lamps are twenty-five candle-power, which some companies claim is the equivalent of the Welsbach light. Other companies employ forty candle-power and fifty candle-power in some cases in response to the demand for a greater volume of light from public authorities. Lamps of the higher candle-powers, sixty-five and 125, are apparently very little used and required for use chiefly on arc lighting circuits in the high ampere ranges. The table on page 857 is interesting as showing the relative percentage demand for street series lamps in the various candle-powers for the two efficiencies. This table shows that ninety per cent and over of the lamps are from twenty to forty candle-power, only with fifty-seven per cent in twenty and twenty-five candle-power.

GENERAL CONCLUSIONS.

Summing up the various points we find that the desirable practice for street series lamps covers the use of twenty-five to thirty-candle-power lamps in the ampere ranges of 3.5 and less, preferably 1.75 amperes, employing a primary voltage of 3,500 to 5,500 giving 100 or more lamps per circuit.

PRACTICAL ADVANTAGES OF INCANDESCENT LAMPS FOR STREET LIGHTING.

The best system of street lighting is clearly that which gives an even light of sufficient intensity over all parts of the street. All forms of street lights give plenty of light near the lamps. The limiting feature seems to be the intensity of light half way between the lamps or at a considerable distance from the lamps where the light is weakest. If the light from the lamp be very strong, that at the half way point is rendered less effective by contrast. This, as we all remember, was the trouble with the old open arc lamp and the basis of improvement rendered by modern enclosed lamps and appurtenances. It is a well-known maxim that uniformity is the chief requisite of good illumination, and this is particularly true of street lighting where a very strong light placed at infrequent intervals may give a poor and unsatisfactory illumination due to lack of uniformity. This lack of uniformity results not only in waste of light over the strongly illuminated area, but still greater waste throughout by the reduction of the sensitiveness of the eye for the light. In many cases, therefore, the total amount of light given and cost of illumination may be reduced materially to the betterment of the illumination.

The series incandescent lamp hardly comes into competition with the arc light which is required for different conditions of service. The incandescent lamp, however, does come into competition with the Welsbach gas lamp, which competition has been quite a formidable one in localities where gas pipes and lamps are already installed.

The series incandescent lamp, however, with the improvements which are now available, should be able to effectually compete with the Welsbach light for street lighting service by reason of the following advantages:

1. Ease of control from a distance permitting lighting and extinguishing lamps as conditions may require, and therefore the ability to take full advantage of a moonlight schedule as the weather permits.

2. Lamps are less affected by weather conditions than the Welsbach lamps. Incandescent lamps lend themselves to better and more accurate testing, so that a more uniform product is ensured. Also variation of pressure causing reduction of light is more readily detected and prevented with incandescent lights than with gas through the facility with which electric current can be measured. Electric incandescent lamps have also a materially better maintenance of candle-power than Welsbach lamps.

3. The light of the incandescent lamp is yellow and more able to penetrate fog and smoke than gas lamps, and these are conditions where the light is especially desirable.

4. Incandescent lamps can be installed along interurban roads and urban localities more readily and at less expense than a similar installation of gas lamps.

5. Incandescent lamps operate so as to throw the light downward and therefore clearly illuminate the space beneath the lamp which is in shadow with gas lamps.

6. The incandescent lamp has the advantage of being suspended over the street or roadway. The Welsbach light is placed on the sidewalk in most cases in line with trees which cast shadows and obstruct the light of the lamp. This last advantage always secures a better lighting effect from incandescent lamps on the houses and buildings on the opposite side of the road than where gas lamps are used.

On the basis of cost, assuming the twenty-five-candle-power incandescent lamp as equivalent in illumination to the ordinary Welsbach, we have the following comparisons:

Welsbach consumes 3.5 cubic feet for 1,000 hours, would cost at $1 per 1,000 for gas $3.50. The twenty-five-candle-power incandescent lamp of the new high efficiency type will consume for 1,000 hours 62.5 kilowatts, which would give an equal cost with that of the gas at a rate of a little over 5.5 cents per kilowatt-hour.

On this class of lighting service, with long hours of use and large number of lamps, such a rate should be a profitable one, and even lower rates might be profitably made. In general, of course, the kilowatt-hour rate is not made, simply a rate per lamp per year, including power and lamp renewals. On the 5.5 cents per kilowatt-hour rate an annual 4,000 hour service with renewals would amount to $15 for a twenty-five-candle-power lamp.

The illumination from street series lamps could be materially improved by the introduction of a suitable and efficient form of reflector for use with the lamps. The form of reflector in general use now is the same that was used ten or fifteen years ago. It presents few points of advantage and could be materially improved upon.

International Association for Testing Materials.

It is arranged that the International Association for Testing Materials, which holds its congresses about every three years in industrial centres in various countries, shall this year meet in the Academy of Science, at Brussels, from September 3 to 8. The King of Belgium accords the congress his patronage, while Prince Albert of Belgium will be one of the honorary presidents, as also will be the ministers of finance, railways, war and trade, and the mayor of Brussels. The programme of excursions includes visits to the harbor works at Brussels and Antwerp, the steel works of the John Cockerill Company, at Seraing, the arsenal at Mechlin, and the harbor works at Zeebrugge. Among the papers to be read will be one on "The Industries of Belgium," by Baron E. de Laveleye and M. Camerman. It is expected that a considerable number of members and delegates from several countries will be present at the congress. Mr. J. E. Stead, F. R. S., Middlesbrough, is the English secretary of this institution.

Single-Phase Railway Equipment for Anderson, South Carolina.

The Anderson Traction Company, of Anderson, S. C., is now actively engaged in building the first section of an interurban road which will eventually connect the city with Greenville, thirty-five miles away. Anderson is the centre of the cotton mill district in the South, and the new line will place it in touch with the surrounding cotton mill towns as well as in closer connection with the main line of the Southern Railway.

In the city there is already a direct-current railway and the first branch of the interurban is a continuation of the present lines as far as Belton, a distance of ten miles. Complete station apparatus and motor equipments for single-phase operation have been ordered for the extension. The new cars are of the heavy interurban type and are each equipped with four General Electric A-605 (seventy-five horse-power) single-phase motors, adapted for operation at 3,300 volts alternating current on the interurban section of the road and at 550 volts direct current on the present direct-current city lines. Each car is fitted with air brakes, for which the motor compressors are adapted for operation on either direct or alternating current, this apparatus as well as the car motors and equipment being furnished by the General Electric Company.

Power for the operation of this road will be purchased from the Savannah River Power Company, delivered at a substation in Anderson at sixty-six and two-thirds cycles. In the substation there will be a three-unit motor-generator set, consisting of an induction motor driver, direct-connected to an alternating-current generator for the single-phase portion of the line and a direct-current machine to supply the present city line. The driving motor consists of a two-phase, sixty-six and two-thirds-cycle, 1,150-volt induction motor, receiving its current from the sixty-six and two-thirds-cycle supply above mentioned. Direct connected to this is a 300-kilowatt, twenty-five-cycle, single-phase, 3,300-volt alternating-current generator, which will furnish the ten-mile single-phase section now under construction with current directly to the trolley at 3,300 volts without substations. The remaining machine for furnishing the direct current consists of a 250-kilowatt, 600-volt railway generator, complete with an exciter on the same shaft as the other three machines.

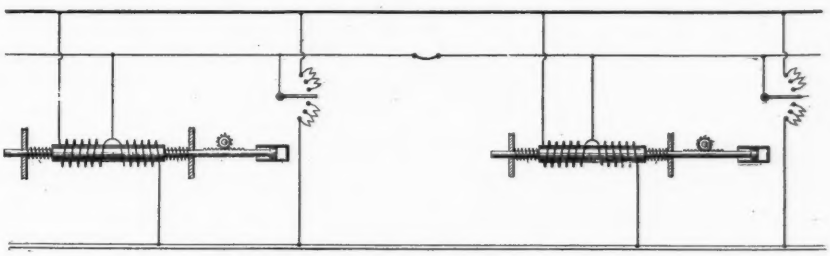
This newest adaptation of single-phase railway apparatus for interurban service indicates that the trolley companies are in the front ranks of the present industrial renaissance now taking place throughout the South. The officers of the Anderson Traction Company are: J. A. Brock, president; F. G. Brown, vice-president; Dr. Geo. E. Coughlin, general manager. The road is being constructed under the direction of J. E. Sirrino, engineer, of Greenville, S. C., with E. F. Lilly, of Columbia, as consulting electrical engineer, and General Electric Company apparatus is being used throughout.

An Interesting Electric Railway Patent.

An interesting system of multiple-unit electric railway control was patented May 22 by Messrs. H. M. Harding and C. M. Clark. The main feature of this patent is that it requires but a single pilot wire. In previous solutions of the problem of electric train control, two or more pilot wires have been used. These wires are carried throughout the train so that the operator can control his train from any point. In the present system but one such wire is employed, which, when combined with the main train line and the track, is able to stop, start, reverse the motors, or run the train at any intermediate speed. Referring to the accompanying diagram the operation of the system will be easily understood. On each car is a magnetic device for operating the regulating apparatus of that car. This device has a double winding upon it, the extreme ends of the winding being connected, the one to the train line and the other to the ground or truck frame. The middle point of the winding is connected to a single pilot wire. The winding of this device is arranged so that under this arrangement current will pass through it in opposite directions in the two halves, each half thus neutralizing the magnetizing effect of the other.

The controller takes the form of a rheostat divided into two sections, one of which is connected to the train line and the other to the ground. There is a contact bar which can be thrown so as to come in contact with a number of points on each of these sections. When it is brought in contact with any section, a circuit is completed between the pilot wire and the train line or the track, which shunts one or the other section of the magnetic device. When this contact lever is in a central position it makes no contact and the magnetic device is held by springs in a central position.

The operation of the device is as follows: supposing the handle of the pilot controller to be moved so as to make contact on the first position of the rheostat connected to the train line, a circuit is thus completed, partially shunting that section of the magnetic controller which is connected between the pilot wire and the train line. On this account the current flowing through the other section winding will be greater than that flowing through the first-mentioned section, and therefore the controller will be moved by this preponderant magnetic force. A further movement of the pilot controller in the same direction causes a still greater difference between the two currents and a further movement of the magnetic controller. When the pilot controller is on the last position the magnetic controller has moved in one direction to the extreme point.



MULTIPLE-UNIT TRAIN CONTROL SYSTEM.

Throwing the pilot controller to the off position allows the magnetic controller to come again to its central position, while if the pilot controller be moved in the opposite direction the other winding of the magnetic controller preponderates and reverses the direction of motion.

It will be seen that in this way the movement of the magnetic controller is governed at will by the position of any pilot controller, and this movement can of course be utilized to effect any desired regulation of the several units in the train.

The claims of this patent cover the use of a single pilot wire in a multiple-unit control system with branches extending throughout the train and connections in the several cars securing desired motion of the car motors; the magnetic devices within the several cars and operable from the said pilot wire; the use of differential or opposed windings in connection with the single pilot wire; controller arms and resistance contacts in the path of these arms and connected respectively to the trolley return, and means for branch connections in connecting these devices for varying the distribution of the potential drop through the windings of the magnetic controlling device.

The Sixth International Congress of Applied Chemistry at Rome.

By John B. C. Kershaw.

ON THURSDAY, April 26, the King and Queen of Italy opened the sixth International Congress of Applied Chemistry in the large hall of the Palais de Justice, at Rome.

Nearly 2,000 delegates and chemists, gathered from all countries of the world, were present to greet their Majesties; Japan, the latest recruit to the ranks of scientific countries, being officially represented for the first time at the congress. After the inaugural meeting, at which the representatives of the leading foreign governments delivered short addresses, the congress divided itself into eleven sections, dealing with the different branches of applied chemistry. During the six days following April 26, no less than 400 papers were read and discussed in the various sections of the congress.

Lectures by Sir William Ramsay, of London, Professor Henri Moissan, of Paris, and Dr. Frank, of Berlin, were also delivered on subjects of general interest during the congress week, and these were attended by practically the whole of the delegates and members. Numerous banquets and receptions formed the lighter side of the entertainment provided for the visitors. It would be obviously impossible within the limits of space allotted to this report to attempt to deal adequately with the work even of one section of the congress. The writer has, therefore, confined himself to brief abstracts, sufficiently long to be of value, of those addresses, lectures and papers which may be assumed to be of especial interest to readers of the ELECTRICAL REVIEW.

INAUGURAL MEETING, APRIL 20.

Address by Professor A. R. Ledoux, representative of the United States Government.

"May it please your Majesties, officials of Rome and fellow delegates. It was unexpected to me that I heard my name just now. For only yesterday did I receive the summons of my government to represent the United States of America at this conference. And I was not aware that I would be asked to speak in the presence of this royal and distinguished assembly. But it is an easy task, and pleasant, at least to thank your Majesty and you the officers and statesmen of Italy and of Rome for this most generous and most hospitable welcome.

"When I report to my government not only the lavish preparations for our comfort and entertainment, but that you Sire and your most gracious Consort have deigned to receive us, I am sure that the report will awaken sentiments of profound pleasure and gratitude.

"Gentlemen of the convention, we have a hard task before us!

"With so much beauty to distract us; such skies above us, and around and beneath us the magnificence of Imperial Rome, how can we spend the time in the serious study of the science we nevertheless love?

"Should this convention, in some future year decide to meet in America, I can promise you an official and a personal welcome. But no state, no city can hope to equal what Italy and Rome have offered to us, with so lavish a hand.

"Again I thank your Majesties and you the representatives of the senate and of the city of Rome for this hospitality and this welcome."

LECTURES TO THE WHOLE CONGRESS.

Professor Henri Moissan, Paris, "The Distillation of Metals," Monday, April 30.

Professor Moissan delivered this lecture in French, and opened by remarking that the electric furnace had permitted us to study a new chapter in science, namely, that of the chemistry of high temperatures. Reactions which are incomplete at the ordinary temperatures could in many cases be carried to their completion in the electric furnace, and in other cases absolutely new reactions and products could be produced. Studies upon the action of carbon in reducing refractory oxides at high temperatures had led to the study of the effect of the maximum temperature attainable in the electric furnace upon the metals themselves. Copper could be easily distilled in the electric furnace—a current of 300 amperes at 110 volts for eight minutes produced 230 grammes of distilled metal.

Gold could also be distilled, though with rather greater difficulty than copper. The metal obtained was in a very fine state of subdivision, and showed the color of purple of Cassius. The metals platinum, osmium, rhodium, palladium and iridium could also be distilled in the electric furnace with rather greater difficulty than gold. The metals of the iron group required the highest temperature, but even these could be vaporized in the electric furnace. A current of 1,000 amperes at 110 volts for twenty minutes sufficed to distill half of a mass of 800 grammes of iron; while the same current and pressure caused 200 grammes of uranium to disappear completely in nine minutes.

Tungsten and molybdenum were the least volatile metals of this series. The earlier experiments of Moissan had proved that carbon, titanium, silicium and boron could be volatilized in the electric furnace.

It was thus proved that all the elements could be converted into the gaseous state at the temperature of the electric arc, which was estimated to be 3,500 degrees centigrade.

Dr. A. Frank, Berlin, "The Direct Utilization of the Nitrogen of the Atmosphere for Production of Manures and Other Chemical Products."

The lecturer commenced by referring to the work of Liebig and to the gradual increase in the consumption of artificial manures in the second half of the nineteenth century. To such an extent had the recognition of the value of artificial manures grown by the year 1900 that no less than 1,200,000 tons of Chili saltpetre (nitrate of soda) and 500,000 tons of sulphate of ammonia were utilized in that year for agricultural purposes. After quoting some figures showing the increased yield of crops obtained by agriculturists in Germany from the soil, due to this use of artificial manures, the lecturer referred to the prophecies of Crookes and André concerning the gradual exhaustion of the natural sources of supply and to the need for opening up new sources of nitrogen upon which to draw for the needs of agriculture in the future. The practically inexhaustible wealth of our atmosphere in free nitrogen was then referred to, and the problem presented by the fixation of this nitrogen in a form which would render it available for agricultural purposes was discussed. The gradual evolution of the process associated with the names of the lecturer and Dr. Caro for the fixation of this atmospheric nitrogen by aid of calcium carbide was described, and the steps taken by the pioneer company formed in Berlin to exploit this process were referred to in some detail.

Direct trials of the produce "calcium cyanamide," or "Kalksticstoff," as this compound is known in Germany, had proved that it was fully equal to ammonium sulphate and sodium nitrate as an artificial manure, and that it could be manu-

factured at a price which would allow it to compete with these two chemical manures.

The lecturer then gave details of the method of manufacture. Calcium carbide is formed in the usual manner by heating lime and coke in the electric furnace, and over this product, while still hot, nitrogen obtained by the fractional distillation of liquid air is passed. The product of this reaction is calcium cyanamide, with the chemical formula $CaCN_2$. As already stated, this product can be used directly on the soil as a chemical manure or it may be employed as raw material for a number of secondary industries, among which the lecturer named the manufacture of pure ammonia, pure nitric acid, ammonia salts, compressed ammonia gas, cyanamide, dicyan-diamide, urea, indigo, and a new compound for hardening steel now being placed in the German market as "ferro-dür."

Dicyan-diamide has been used for the purpose of reducing the combustion temperature of rifle and cannon powders with striking results.

As regards the industrial development of the Frank and Caro process for manufacture of calcium cyanamide, the lecturer stated that two works were already planned for Italy, at Piano d'Orte and Fiume, respectively, and that the first of these was already in operation. Other works were to be erected in France, Spain, Switzerland and Norway at an early date. As regards yield, the best results obtained so far represented the fixation of 330 kilogrammes of nitrogen with the expenditure of indicated electrical horse-power year; but the lecturer was convinced this amount could be increased, as calculation showed that it was only forty-three per cent of the theoretical yield.

Dr. Frank closed his address with remarks upon the importance of this new industry for Italy, which possessed enormous reserves of water power yet undeveloped, and a population largely dependent upon the growth of agricultural industries.

PROCEEDINGS IN SECTION X—ELECTROCHEMISTRY AND PHYSICAL CHEMISTRY.

By H. Moissan, Paris, "Note Upon the Silicide of Carbon."

Professor Moissan in this paper described some new researches upon the silicide of carbon—represented by the chemical formula SiC. He recalled the conditions under which Schutzenberger had prepared the amorphous compound, and Acheson at a later date had prepared the crystallized compound in the electric furnace. Finally he described some new forms of the same compound obtained by himself, and stated that we had proof of its existence in nature by the fact that it had been found as one of the components of the meteorite which fell in the Canon Diablo in the United States.

By Guntz, Nancy, "Note Upon the Constitution of Sub-Salts and Their Production by Electrolysis."

By heating metallic lithium and its chloride in a current of hydrogen, the proportions being in accordance with the equation $LiCl + Li$, the author obtained a white product having approximately the composition Li_2Cl.

New experiments had proved that the presence of hydrogen is necessary in order that the reaction may occur, and the product may be considered a mixture of hydride and chloride of lithium $LiH + LiCl$. A similar reaction had been observed by the author with regard to the action of calcium upon calcium chloride. When operating with moist substances, one obtains mixtures of oxide and hydride, as in the electrolysis of the fused chloride.

Professor Bruni, of Milan, enquired whether it was not possible to prove the existence of a subchloride by studying the curve for the solubility of the lithium in the chloride. Guntz replied that this method of proof was inapplicable. Ostwald stated that even the small quantity of lithium absorbed by the chloride was probably in a state of solution and not of combination. Guntz admitted the possibility of this explanation.

E. Mazza, Turin, "The Applications of Centrifugal Force for Separation and Extraction of the Components of Gaseous Mixtures."

(This paper is of interest to boiler engineers in that it has been asserted that in Italy intensive combustion in boiler furnaces has been attained by use of air which has been concentrated as regards its oxygen contents by centrifugal force.)

The experiments carried out by the author with apparatus, which he briefly described, have led him to believe that a centrifugal apparatus for separating mixed gases must comply with the following conditions in order to give the best results:

1. The greatest possible tangential velocity.
2. The minimum radius of rotation.
3. Maximum time duration.
4. Greatest superficial surface between the gaseous layer which is to be impoverished and the gaseous layer which is to be enriched.
5. A minimum thickness of the said gaseous layers.

The author finally gave details of some good results obtained by this method.

In the discussion on this paper Bodenstein referred to the earlier experiments of Bredig with mixtures of hydrogen and iodic acid in this field of research.

Nernst asked whether the results obtained by Mazza were in accordance with theory. The author answered no, and referred to the previous work of Haber and Bredig. Goldschmidt asked if they might be allowed to see a sketch of the author's apparatus, but this was refused as the patents were not finally completed.

Nasini said that he also had interested himself in this matter, but had obtained only very small enrichment of the gases with a Mazza apparatus of an old type. Therefore he thought that with better apparatus and a higher velocity he might have been able to obtain a better result, and he was pleased to hear that the author believed he had obtained such in his own experiments.

R. Nasini, Padova, "Chemico-Physical Researches Upon the Spring Waters of Anticoli."

This research was carried out in conjunction with Dr. Levi and related to the radioactivity of the springs of Fiuggi (Anticoli), the electrical conductivity of the water and the special action which this water had upon oxygenated water and upon calculus or gravel. This action might be explained by the presence in the water of some colloidal catalyte.

The authors attempted to trace a relation between the noteworthy radioactivity of the spring water and the large quantities of ozone which they found in the air of Fiuggi. Rocks were also found in the neighborhood of the springs which were strongly radioactive and contained notable quantities of barium, titanium and vanadium.

Another paper upon a similar subject was that by G. Bertoni upon "The Chemical Composition of Sediment from Hot Mineral Springs in Relation to their Radioactivity."

The sediment referred to contained considerable quantities of arsenic, barium, strontium and manganese. The figures relating to the radioactivity were furnished by Dr. Megri and by Professors Nasini and Levi.

C. Doelter, Gratz, "The Dissociation of Fused Salts."

This paper was read, as introduction to a discussion upon the dissociation of fused salts in general, with especial relation to the electrolysis of these.

The author stated that he had been led to the study of this subject by his previ-

ous work upon the fusion of silicates, in connection with which he had noticed that the dissociation of the "ion" groups increased rapidly with the temperature after the melting point was passed. This result is peculiar to the silicates, for previous observations upon other salts had shown that the melting point caused no marked change in the tendency for the "ions" to dissociate when the salt was heated, but that the dissociation commenced in the solid state. The dissociation of double salts of complex constitution is the most important, and in the case of silicates it is in many cases directly observable. Such salts have then two melting points, and the results observed differ according to the rate at which the heating of the salt is carried out. For the proper study of this subject it was necessary that the influence of the dissociation upon the melting curve should be observed, and it would be found that this curve became flattened as the number of dissociated "ions" increased.

An interesting discussion, in which Abegg, Drücker, Grossmann, and Bruni and Miolatti joined, followed the reading of this paper.

An Innovation in Street Lighting.

The accompanying illustrations show a new design of street lamp which is being used on Michigan avenue, Chicago, Ill. The South Park commissioners have recently installed these posts as an experiment, and it is stated that, aside from the probable cost of maintaining so many incandescent lamps to the block, instead of a small number of arc lamps, there is every reason to be satisfied with the change. As it is, the comments concerning the beauty of the fixtures and the very satisfactory condition of the lighting are highly favorable.

The new posts each carry five incandescent bulbs bunched together at the top of an ornamental shaft. The post is of the Colonial style of architecture, and is eight feet high. These posts are placed upon each side of the avenue, eighty feet apart. While at night they are giving good illumination in the daytime they make a handsome addition to the appearance of the boulevard.

A. R. Gerlach, Chicago Edison Company, Chicago, Ill.

NEW LAMP POST ON MICHIGAN AVENUE, CHICAGO, ILL.

A. R. Gerlach, Chicago Edison Company, Chicago, Ill.

NIGHT SCENE OF ILLUMINATION OF MICHIGAN AVENUE, CHICAGO, ILL.

Annual Electrical Shad Eaters.

Mr. Charles E. Trump, president of the Novelty Electric Company, of Philadelphia, gives an annual planked shad dinner to a coterie of New York friends, and the event this year came off on Tuesday of last week. The shad were specially caught at Washington Park that morning, and were planked by a kitchen artist and eaten and enjoyed by the visiting gastronomic artists, who agreed that this best of all fishes never tasted better and was never better served and environed.

This is the thirteenth year that Mr. Trump has given the shad dinner, and five of those present had attended all the previous dinners. Among those in attendance, besides the host, were Colonel Ezra De Forest, Major W. L. Candee, Geo. T. Manson, H. Durant Cheever, W. H. Hodgins and E. B. Baker. A group photograph was taken, and it was unanimously voted that all would attend next year—if invited.

Illuminating Engineering Society.

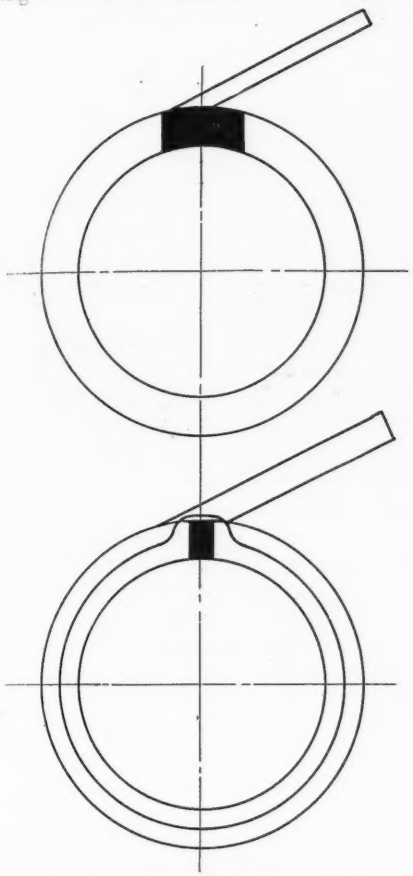
The Illuminating Engineering Society will meet in the Edison Auditorium, 44 West Twenty-seventh street, New York city, Friday, June 8, at 8.15 P. M.

Dr. Louis Bell will read a paper on "Some Physiological Effects in Illumination and Photometry."

LETTERS TO THE EDITOR.

Note on an Alternating-Current Homopolar Dynamo.

In the last issue of the ELECTRICAL REVIEW, on page 796, a letter from J. E. Noeggerath, Schenectady, N. Y., was printed, giving a brief discussion concerning the characteristics of a new unipolar



FIGS. 3 AND 4.—A NEW ALTERNATOR.

alternator. An addition to this note was received too late for publication. This addition is as follows:

"Please add to the end of this note, after the words 'with the exciting winding as primary,' the following sentence: 'to insert only one gap per ring is objectionable in most cases, because the brushes, when touching these gaps, either (Fig. 3) open the circuit, or (Fig. 4) reestablish for a moment the electric continuity of the rings.'"

J. E. NOEGGERATH.

No Earthquake Damage at Los Angeles, Cal.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

It might be of interest to you to know, in view of the misleading reports that were sent out during the recent earthquake disturbance at San Francisco of the amount of damage that had been incurred in and around Los Angeles, that in connection with our plants and holdings, which are operated over a strip of territory approximately 100 miles wide and 300 miles long, with numerous transmission lines, water-carrying conduits consisting of cement line ditches, tunnels, flumes, pipe lines and power-houses connected therewith, there was not one dollar's worth of damage done to this company by reason of earthquake or any unusual disturbance.

In the city of Los Angeles, where we have a large steam plant, we were not aware that an earthquake had happened on the morning of the San Francisco disaster until word had been received by telegraph from Oakland. Contrary to the exaggerated reports as sent out by certain newspapers, Los Angeles and the country for 200 miles around experienced only a very slight shock, which was not perceptible to more than one per cent of the inhabitants. A slight shock was felt on Friday, the 20th, which did no damage whatever, and which was scarcely felt by others than those in the tops of tall buildings.

The electrical development throughout Southern California has been pushed ahead more vigorously than ever, and we are just at the present time making preparations for the installation of a 15,000-kilowatt plant at Redondo, to be used in connection with the operation of the Los Angeles and Pacific Electric Railway companies' local and interurban service.

E. A. BECK,
Superintendent Pacific Light and Power Company.

Los Angeles, Cal., May 21.

"A Comparison of English and American Practice."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have only recently noticed in your issue of March 17 a letter from Mr. J. Franklin Stevens in which he refers to some new iron-cored alternate-current instruments I have devised.

It seems to me that Mr. Stevens has only seen a very brief abstract of my paper on the subject, or else he has read it very hastily, for he has entirely failed to see the main point of the matter. He says I propose "an electromagnet field which is excited by the current to be measured." Now this is precisely what I have said should not be done if the errors due to varying permeability and hysteresis of the core are to be avoided. What I have proposed is to use a shunt magnet excited by the voltage to be measured. In this case the relationship between the voltage and the resultant magnetism is entirely independent of permeability and hysteresis in the core, and such error as exists is due not to the iron, but to the resistance of the copper winding. It is the same as with ordinary pressure transformers. The open-circuit voltage on the secondary is a measure of the flux in the core and is related to the primary voltage in a way quite independent of the properties of the iron, and is mathematically definite whatever the frequency or wave-form. The only disturbing factor is due to the copper drop in the primary winding. Difficulties arise owing to the quadrature relationship between the voltage and the flux, but these I find can be easily overcome, and they will be found fully discussed in my paper, of which I am sending you a copy.

If Mr. Stevens can see no advantages about iron-cored alternate-current instruments, I am afraid we must agree to differ. He admits that the permanent magnet type of instrument is "now almost universally used in this country for direct-current measurements." How is it that the dynamometer instruments made by his firm do not displace these direct-current instruments? Perhaps it is because the self-induction error of his instruments is, as he states, 0.00013 per cent on alternate-current circuits. This is an error to be proud of. It would be such a pity for it to disappear on direct-current circuits. However, the worth of an instrument really depends upon its overall error in working, not upon the smallness of some particular source of error. I could mention several errors about my instrument each much smaller than this.

Mr. Stevens refers to my instruments as "curiously out of date," though these instruments have not yet been used commercially, and he heads his letter "a comparison of English and American practice." He also says "it may be that the dynamometer type of instrument is not known in England" and suggests "it would be profitable for some English engineer to visit this country long enough to observe the results we have been obtaining with this type of instrument for many years past." These suggestions are delightful. W. E. SUMPNER.

Technical School, Birmingham, May 14.

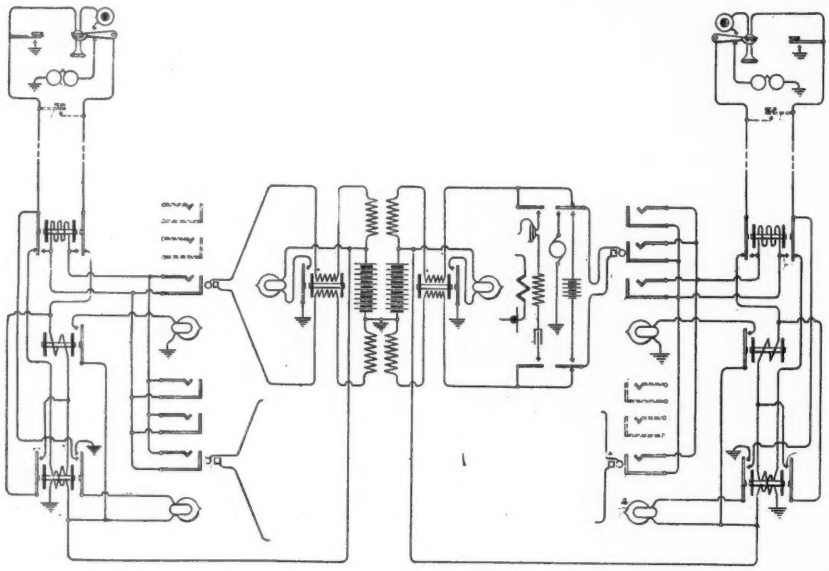
Meeting of Telephone Men.

The Southwestern Iowa branch of the Iowa Independent Telephone Association met at Council Bluffs, Iowa, on May 11, and discussed methods of apportioning terminal charges on toll line business. The determination was left with the state clearing-house officials. Frederick C. Musson, of Atlantic, was chosen as delegate to the National-Interstate convention at Chicago, Ill., June 26-28. H. A. Kinney, of Woodbine, was named as alternate.

District officers were elected as follows: president H. A. Kinney, Woodbine; secretary and treasurer, J. F. Glenn, Denison.

Electrical Patents.

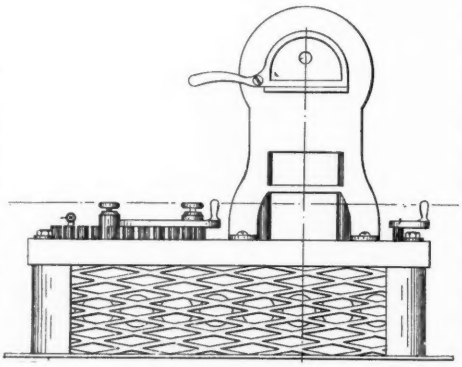
John Henry Lendi, of Chicago, Ill., has obtained a patent (820,803, May 15) for an improved two-division telephone system, which he has assigned to the Kellogg Switchboard and Supply Company. This invention relates to a two-division multiple switchboard telephone system, the object being to provide a system of the



TWO-DIVISION TELEPHONE SYSTEM.

kind described in which the source of current for the actuation of all substation and central office apparatus is located at the central office and in which the apparatus both at the substation and at the central office for accomplishing the desired operations and results are of simple character. In carrying out this invention the operating batteries or sources of current are located at the central office and provided with a cash subscriber's line with two line relays, and a cutoff relay. The subscriber is enabled by suitable switches or keys to actuate either of the line relays to selectively operate the desired signal, and when the subscriber answers to his call the cutoff relay is actuated to render the signaling device inoperative. The operator's apparatus is provided with the usual supervisory signals, whereby she is informed of the condition of the connected lines at all times.

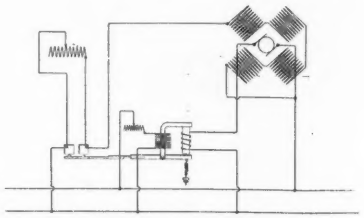
Daniel G. Steinecke, of New York, N. Y.; Samuel Steinecke and William Steinecke, administrators of Daniel G. Steinecke, deceased, invented certain new and useful improvements in an electric dental furnace (820,025, May 8). This invention relates to electric dental furnaces, and is an improvement on that specifically known as the "Hammond" electric furnace; and the object of this invention is to provide a dental furnace in which porcelain inlays or dental work of other kinds and classes may be brought to a high degree of temperature for baking or other similar purposes, a further object being to provide an electric furnace of this class in which the muffle is composed of two parts and is readily detachable from the furnace proper, and a still further object being to provide a muffle for furnaces of this class, the two parts of which may be electrically energized singly



ELECTRIC DENTAL FURNACE.

or together. The invention consists of a base, vertical standards secured thereto, a casing open at its top and connecting these standards, a cylinder filled with refractory material resting in the open top of the casing, the refractory material being provided with a central segmental opening, a muffle detachably mounted in this opening, the muffle being composed of an upper and lower member, an electric heating circuit arranged in the walls of the upper member, an electric heating circuit arranged in the walls of the lower member and means for energizing the electric heating circuits.

An improved automatic speed-increasing device has been invented by George Baehr, of McKeesport, Pa., which he has assigned to the National Tube Company, Pittsburg, Pa. (819,707, May 8). This invention



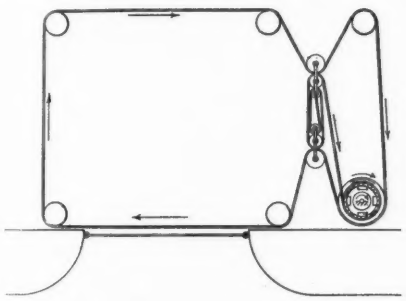
AUTOMATIC SPEED-INCREASING DEVICE.

relates to electric motor systems, and its object is to provide a system of this kind, whereby a motor can be driven at two speeds, a low speed and a high speed, and whereby the change from the one speed to the other will be brought about automatically by the load on the motor. More specifically stated, the object of the invention is to provide a system of this character, which is adapted to drive a motor at a given low speed when running idle or under a friction or light load, and at a greater speed when running under a heavier load, this result being brought about by automatically varying the resistance of the motor field. The invention also consists in providing a system of the character specified with manually controlled means whereby the system may be set to secure various rates of speed of the motor when running at its higher speed and in which when so set the change from the low to the higher speed will take place automatically. The invention consists of a self-regulating system for electric motors whose armatures are constantly under load, comprising a motor, a source of current therefor, automatic means controlled by the load on the motor and arranged to increase the resistance of the motor field circuit when the load on the armature increases and to decrease the resistance of the field circuit when the load on the armature decreases, and manually-controlled means for varying the higher resistance of the field circuit.

John Milton Seibert, Pekin, Ill., has obtained a patent (819,814, May 8) for an improved initiation apparatus. This invention relates to that type of theatrical appliances known as "initiation apparatus," designed for use in lodges and secret societies for initiating a candidate into the

secrets and forms of the order. To this end the invention contemplates a simple and practical form of apparatus entirely harmless in its action and results, while at the same time producing an amusing and entertaining effect. The invention consists of an apparatus comprising a pair of spaced metallic rails included in an electrical shocking circuit, and a pair of shiftable electrodes, each electrode consisting of an insulated walking shoe provided with exterior sole and heel plates for contact with said rails, and with an interior foot plate metallically connected with said sole and heel plates.

Otto Adam, of Dresden, Germany, has obtained a patent (820,464, May 15) for an improved self-acting electrical rope-straining device. This invention is intended to devise means for effecting the straining or tightening of a feeding rope arranged in a circuit or of any tight rope along which

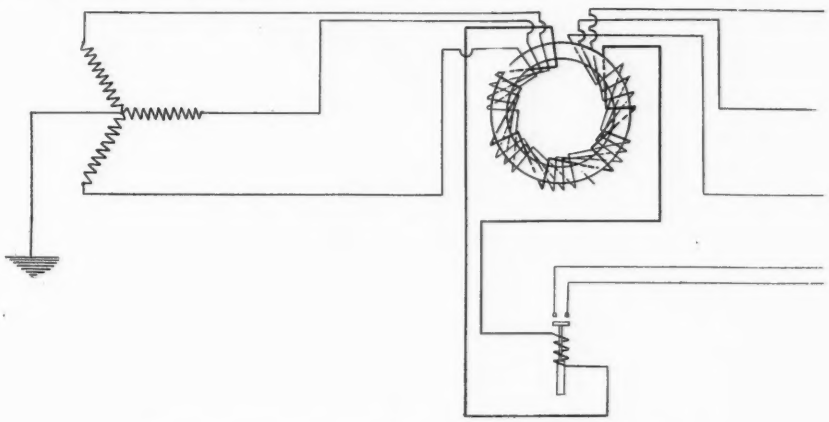


Self-Acting Electrical Rope-Straining Device.

a trolley or the like is moved by automatic means, while allowing of varying the distance of the stationary rollers around which the rope is taken or the distance of the fixed points between which the rope is to be kept taut. This is especially of importance in the case of loading coal or the like from a boat or trailer towed by a ship and into the latter or, inversely from the towing boat into the towed boat or other conveyance, inasmuch as in this operation the distances of the fixed points are changing in consequence of the undulating movement of the water or in consequence of difference in the speed of both vessels or boats. The invention consists in the combination with the endless band or cable, idle pulleys or drums located in proximity to each other over which the cable passes, a take-up pulley riding on the cable between the first-mentioned pulleys, and electric means for automatically drawing upon the take-up pulley or releasing it according to whether the tension upon the cable decreases or increases.

George M. Haas, of New York, N. Y., has obtained a patent (820,569, May 15) for an improved target apparatus. This invention relates to the class of target devices or apparatus wherein the spot or object aimed at by the marksman is indicated electrically and wherein a firearm or something which simulates a firearm—as, for instance, a gun or pistol—is employed, but no explosive or projectile is used. A target apparatus belonging to this general class is described and claimed in a patent No. 679,325, granted to the Automatic Target Machine Company, July 30, 1901, and this patent may be referred to as fairly illustrating the art to which the present invention belongs. It may be explained that in this patent the target aimed at by the marksman is of the usual form, having a bull's eye and rings or zones and wherein only the success is signalized, this being effected by an indication visible to the eye. The object of the present invention is to provide a target apparatus otherwise similar in principle to that shown in the before-mentioned patent, but furnished with means for signalizing to the marksman a "miss" as well as a "hit." The miss may be signalized by sound, as with a phonograph, or by sight or semaphorically. The invention consists of a target apparatus having a universally mounted simulated firearm, a target to be aimed at, electrically operated means adjacent to the target for signalizing to the marksman his failure to aim correctly at the target, electrically operated means at the target to signalize to the marksman his success in aiming correctly thereat, circuit-closing devices adjacent to the firearm, and made operative by pulling the trigger of the firearm, and circuits connecting the respective circuit-closing devices with the signalizing devices at the target.

An improved safety device for alternating-current distribution has been invented by George N. Eastman, Chicago, Ill. (818,424, April 24). The invention relates to safety appliances for use in alternating-current distributing systems employing two or more conductors, and the object of the invention is to provide an electrosensitive device adapted to be automatically operated from an alternating-current system for indicating a ground or breaking the circuit on which a ground occurs. The invention consists of a plurality of circuit conductors arranged on different sides of the system and their electromotive forces differing from each other in phases, a group of independent windings insulated from each other, one for each of the circuit conductors, arranged in close promixity and bearing the same inductive relationship to each other, whereby the inductance is neutralized when the vectorial sum of the currents in the circuit conductors is zero, and an extra coil for controlling an electrosensitive device, the extra coil being in position to be inductively energized by any one of the first-mentioned coils.



Safety Device for Alternating-Current Distribution.

Novel Suggestion from Berkeley.

Ex-Secretary of the Treasury Charles Stebbins Fairchild informed the Berkeley College Commerce Club recently, in an informal address, that the only action he could suggest to stop the concentration of power in the hands of a limited number of financiers is to stop the use of steam and electricity.

"In my opinion," said Mr. Fairchild, who was in Cleveland's first cabinet, and who is a banker of renown, "the so-called concentration of power in the industrial and financial world to-day is due almost entirely to the improvements in transportation methods. The foundation of these improvements is the use of electricity and steam. If we want to do away with concentration, then I am afraid we will have to dispense with electricity and steam."

Old-Time Telegraphers and Military Telegraph Corps.

At a meeting of the executive committee of the Old-Time Telegraphers' and Historical Association, called by President W. H. Young, and held on May 24, in Washington, D. C., partial plans were made for the next annual reunion of the association, in connection with the Society of United States Military Telegraph Corps, to be held on October 9, 10 and 11. The Arlington Hotel, which is beautifully located, facing Lafayette square, just opposite the White House, was selected as the headquarters and place of meetings of the two associations, very advantageous terms having been made with the proprietors. It has been definitely arranged that a special reception to the telegraphers and their families will be given by President Roosevelt at noon on the 10th, when the White House rooms will be opened to the visitors. Other features of the entertainment to be provided by the Washington telegraphers, now under consideration and which will, doubtless, be adopted, include an evening reception in the Corcoran Gallery of Art, when an opportunity to view the rare works of art in its collection will be afforded; a special concert by the Marine Band at the navy yard; a dinner at Cabin John's Bridge; an exhibition of cavalry drills and exercises at Fort Myer, near Arlington; a trip to Mount Vernon and an evening at Chase's Opera House. The various special excursions, etc., will be so planned that the friends can conveniently visit all other places of interest.

The Demand for Copper.

Electrical engineers in the direction of the larger apparatus factories are all of the mind that the tremendous demands for copper in 1907 will doubtless cause an advance of prices for lake and electrolytic that will make present quotations seem low. American manufacturers of electrical supplies find by studies of plans decided upon in North America and Europe for hydroelectric power and railroad and telephone installations in 1907 that the volume will be largely in excess of the contracts awarded in the last eighteen months. In hydroelectric power transmission undertakings alone that have been determined upon for construction in Europe and America during 1907 statistical engineers estimate that 175,000,000 pounds of copper line material will be required. Switzerland is planning the nationalization of her sources of water power in order to electrify her railways. Italy, in pushing Genoa to be the first port of the Mediterranean, is going to add largely to her electrified roads. Germany, France, Austria, Belgium, Holland and Great Britain are about to begin electrical engineering works of great magnitude. The London county council has decided upon building fourteen great electric power installations, and the amount of work coming on in North America is astonishing electrical engineers. Telephone engineers at home and in Europe are all certain that 1907 will break all records for the consumption of copper wire. —*New York Sun.*

Intelligent Use of Electricity.

Mr. E. R. Weeks, past president of the National Electric Light Association, at the recent annual meeting of the Manufacturers' and Merchants' Association, of Kansas City, delivered an interesting address on applied electricity. He criticised the uneconomic work done on and by many plants, and said: "ignorance of good practice in electrical engineering is equally expensive to the merchant. Since he usually has no knowledge by which to determine the kind of machinery best suited to his needs or the proper cost of its operation, he, too, is at the mercy of the unscrupulous vendors of current and apparatus. A certain hydraulic elevator in this city is now costing $3.49 per car mile, while an electric elevator in the next block with one-third more load costs by meter only thirty-six cents per car mile. On the other hand, a new pair of lifts operated by electricity at four cents per kilowatt-hour by meter was recently costing $350 per month, while another pair of purely mechanical lifts doing much more work were costing only $142 per month. After thorough test and reconstruction the cost of running a pair of electrics dropped to $65 for last month, although the service had increased ten per cent."

As to the beauty and value of electrical products and the fine skill needed in their manufacture, he remarked: "as manufacturers and vendors of industrial products, it will interest you to hear that in the electrical arts is now found the most costly pound of manufactured product. It has been supposed that a pound of hair springs has the greatest pecuniary weight, being at wholesale rates $42,000. I feel sure that those among you who have paid this price will be surprised at the statement of fact that the wholesale cash value of one pound of carbon filaments for incandescent lamps is $60,000, or 199 times its weight in gold. Some of you who are accustomed to buy and sell by the carload may think that the purchase of one pound of a commodity should be called a retail transaction; but when I state that 42,000 hair springs or 30,000,000 filaments are required to balance a pound of butter, I think you will all agree that even as small a weight as an ounce of either, would constitute a wholesale consignment."—*Journal of Electricity, Power and Gas.*

ELECTRICITY AND INSURRECTION.

BY L. LODIAN.

Several years ago the writer was in Spain when the telegraphic operators struck work —not for an increase of wages (pitiable as they were), but because they could not get any wages at all. The government was four or five months' pay in arrears to them —with that state of affairs prospective of becoming worse,—and the operators became wearied of living on credit, with its enhanced interest-bearing increment, and the exactions of Jew usurers; and equally wearied were the tradesmen of "tenter-hooking" along on the prospect of also realizing nothing from their supplies on credit. And all the time thieving officials in high places secured all the loot they wanted, but, worst of all, did not even spend their "graft" in the country, but took the money abroad, squandering it in riotous orgies at Paris, Monte-Carlo, Vienna, etc.

After months of secret arrangement, the operators struck work to a man throughout Spain. They knew that unity meant success in this life-struggle. After a few days, the government had to yield, paid up all arrears (the employés knew too well the "value" of an official "promise" to pay), whereupon work was resumed; and some of the sundry high-up grafters had to forego their loot, and,—no more money being forthcoming,—returned home from their foreign orgieings. Of course, it is this looted money which should have gone to pay not alone the operators, but the school-teachers and like humble employés of the state. Unfortunately, most of these workers are unable to help themselves; and the church and state in Iberia would only be too glad to see a lasting-for-ever strike of school-instructors throughout Spain, as they "only learn the people to know too much."

The foregoing introductory to the state of affairs in Russia. But in Russia, official loot and living conditions with the operators are far worse. In Iberia (southern Europe) they do at least have a genial climate to live in, with luscious fruits and pure wines all the year round at prices scarcely worth mentioning; whereas, in the rigorous climate of Siberia and Russia, the operator only knows such luxuries on the occasion of his marriage, or the marriage of somebody else. Otherwise his existence is almost a dog's life, subsisting on potatoes, black bread, brick-tea, and (in Russia) meat "once a week," the meat diet, however, increasing more—due to greater abundance—as you proceed east across Si-

beria. He can only be said to have two "luxuries"—dubious ones at that—*i.e.*, vodka (gin) and cigarettes. His pay—when he gets it—will average thirty-five to forty rubli per mensem, but its purchasing-power is equal to only about $20 United-States currency. Imagine an American operator trying to live on $5 a week! Then, in the cities, the Russ has to find his own lodgment, also costume; and maybe has a "rabbit-warren" of young mouths to fill. The poor wife!—well, let's pass on.

With the mass of the Russian working classes, matters are worse still. Can it be wondered at, then, these predisposing causes to insurrection and revolution?

The few illustrations interspersed through this short paper are an answering effect to a predisposing cause.

The Russian operators shared with the rest of the submerged tenth of slave-toiling slafdom their "griefs and sorrows," and did what they could for them in their temporary control of the lines of communication, with the result (the insurrection having failed) that hundreds of them—bright young fellows, mostly—still continue in prisons and fortresses "awaiting trial" (we all know what a Russian "trial" means), while many have shared a worse fate, and are perhaps better off dead than alive. It is these imprisoned unfortunates—along with thousands of others—that the cable announces the new national assembly are striving to have amnestied. An amnesty for having striven to improve their lot above that of a dog's life! Some of my own personal acquaintances are, I believe, among those in durance vile,—not having heard from them for a couple of years; or maybe they have been "insurrected" the "milky way."

Our views are from photogravures made a few days after the dispersal of the insurgents, when things had quieted down a lot, and show the insurrectionists' heterogeneous utilization of everything conceivable for the forming of street-barricades,—street-cars; telegraph posts with their entangled wires felled bodily across the thoroughfares (an obstruction not to be despised); torn-up rails; the huge lead-pipe-coil wheels (such as are a familiar sight with repair crews on Manhattan streets)—weighty enough in themselves almost sufficient to wreck an ironclad, were it possible for one "to run foul" of the other; the massing of overturned vehicles and obstructions of every description; and,—gruesome to relate,—the heaping and packing of fallen dead bodies among the debris and interstices of the barricades, to help shield the defenders. Unfortunately (or fortunately), this human-corpse-bedecked barricade—some with their ghastly wide-open eyes—is missing from my collection; (but a few of which there is space to reproduce here). To my friend L. Loxbicki, of Omck, Pocia, thanks are due for views and data.

Still "the whole thing" vividly reveals the troublous crisis through which Russia passed only a few months ago. And those are comparatively tame views compared to what actually occurred—taken after the destruction of the more important barricades.

"And the end is not yet!"

ELECTRICITY AND INSURRECTION—SCENES IN RUSSIA DURING THE RECENT CIVIL DISTURBANCES.

Reviews of Current Engineering and Scientific Literature.

The Design of Electric Generators.

In this article Mr. W. O. Horsnaill considers the mechanical features in the design of electric generators. He first takes up the shaft and treats this as a cantilever loaded at the centre. In this way he develops a formula involving the use of a coefficient, which has the advantage that, by applying it to a number of different shafts, a figure is obtained showing the comparative merits of the design. For example, when the figure for the coefficient thus obtained is too large, the shaft is too weak, which was proved to be the case under test by the pulling over of the armature against the poles when the field of the machine was excited. The allowance made for this pull is thirty pounds per square inch over the projected area of the armature. The force thus exerted is considerably greater than that due to the weight of the shaft. The size of the bearings is next taken up and treated in much the same way. The results are applied to a number of different machines, and the relative merits of the different designs are pointed out. The third problem is the design of the frame. This is considered as a beam supported at each end and loaded in the middle, the length being equal to the inside diameter. Applying the formula thus obtained to a number of machines, a considerable variation was found in the results. In some cases the coefficient was only one-fifth of that in others. In the latter machine it was evident that a great deal more metal had been used than was necessary. The formulæ developed for each part are simple and easily applied. Some suggestions are given regarding the proper coefficient to be used in each case.—*Abstracted from Engineering (London), May* 11.

Control at a Distance of Submarine Boats.

An account is given here by M. J. A. Montpellier of some recent trials with a small submarine boat at Antibes, France, in which the boat was controlled entirely by means of Hertzian waves sent out from the shore. The particular vessel tested here was not really a submarine, as it could not be submerged; but the main part of the vessel was entirely beneath the water. The vessel consisted of two cylindrical bodies with conical ends. The lower, and larger, one contained all the mechanism for driving and controlling it. The upper, which was attached to it by braces, served, in part, to support the lower section, and carried also two short masts which showed the position and direction of the vessel and served as receiving antennæ. The machinery for propelling and controlling the vessel was placed in the rear portion of the lower section. The forward section is intended to receive a charge of explosive, while the mid-section carries a battery of storage cells. The vessel is controlled by means of a rotating switch or commutator, which closes a number of circuits on board, this stopping, starting, increasing the speed or steering the boat as desired. This controller is governed by means of electric waves sent out from the shore. One spark moves it to one position, two to the next, and so on. The controller can be rotated in two seconds, and there are twelve sets of contacts upon it, so that any one controlling mechanism can be brought into action within one-sixth of a second. During the tests the vessel obeyed the operator readily, and was caused to manœuvre about and around a battleship. In addition to the driving and controlling mechanism two lamps are placed, one on each mast, which can be lighted or extinguished at will from the shore. These enable the course of the vessel to be followed during the night. The vessel which was tested weighed about seven tons. It was about thirty-five feet long, and the larger portion was three feet in diameter. No mishap occurred during the test, which was carried out successfully.—*Translated and abstracted from L'Électricien (Paris), May* 12.

A New Form of Arc Lamp of High Candle-Power Employing Radiating Bodies or Conductors of the Second Class.

A description is given here by Herr E. Stadelmann of a new type of arc lamp which, it is claimed, has some valuable and peculiar features. The lamp depends for its effect upon the use of a conductor of the second class—that is to say, an electrolyte. This principle has been employed previously—in fact, it was used some fifty years ago. The most noteworthy instance was that of the Jablochkoff candles. It was also used in the "soleil" lamp, due to Clerc and Bureau. Bodies of this character are frequently non-conductors at ordinary temperatures, but become conductive at higher temperatures. In the particular lamp here described this body is placed vertically over the arc, and the arc itself is struck between two horizontal opposing carbons. To start the arc the carbons are brought into contact. The heat of the arc raises the non-conducting body to a temperature at which it becomes conducting. This allows a greater current to flow, and consequently the arc is lengthened. The action being repeated until the current is cut down to the normal amount. The arc thus produced is longer than that employed under normal conditions, and a good portion of the current flows through the intermediate heated body, only the smaller portion passing directly across through the air. The effect of this arrangement is to add a third radiating body, which is maintained at a high temperature, and which may have a high luminous efficiency. It acts also as a good reflector and throws the light down through the lower hemisphere. Further, it acts as a light accumulator, since its temperature does not vary as quickly as the temperature of the arc may. It therefore causes the lamp to give a more steady light. The materials used for this purpose must be very refractory, so that they will withstand the action of the arc well. At the present time such a material has been found in the so-called "chamotte," which does not drop down, although it becomes soft. It is very probable that a still better material will be found for this purpose. These lamps give a very high candle-power, and on account of the peculiarity of the light distribution, are suitable for lighting high rooms. It is not essential that the two carbon rods should be placed horizontal, as they may be inclined at an angle or even placed horizontal and the second-class conductor be placed between them, which arrangement will give a more uniform spherical distribution of light.—*Translated and abstracted from Elektrotechnische Zeitschrift (Berlin), May* 3.

Wireless Telegraphy.

A résumé is given here by Professor Reginald A. Fessenden of the work he has done during the last few years in wireless telegraphy. He first calls atten-

tion to the number and types of instruments which he has found suitable for various stages of the work, and then gives some very interesting results of recent tests. He had found that the intensity of the received signals varies very greatly on different days and during different parts of the day. There seems to be no reflection, but at times there is a great absorption of the energy, with consequent weakening of the signals. His experiments, conducted over distances from 200 yards up to 3,000 miles, indicate that the law followed is that of the inverse squares, but, in all cases, the signals were weaker than this law would indicate, due apparently to absorption. This absorption did not take place at the two stations, but at some intermediate point. A peculiar effect noticed during the transmission of signals from Machrihanish, Scotland, to Boston, Mass., was a second or echo signal, received about one-fifth of a second later than the first signal. This signal was considerably weaker than the other, and, for various reasons, the author believes that it reached Boston by going the longer way round. Applying the law of the inverse squares to this assumption, it was found that these signals were stronger than this would indicate; but, for other reasons, not given, this proof is not considered conclusive. The amount of power used during these tests was four horse-power, and on a certain number of occasions messages were exchanged over this distance of 3,000 miles, using but a single horse-power. It is now intended to increase to fifty horse-power the transmitting equipment, and at the same time to increase ten times the sensitiveness of the receiving instruments. This is necessary because the variation of the intensity of transmission is so great for different nights. On some nights it was 400 times greater than on others. From tests carried out between stations on the Amazon river it was found that there were apparently absorbing clouds in the tropical regions at a considerable distance above the earth. The difference of intensity of the signals, as received during the night and during the day, was very noticeable. With less sensitive instruments this change is quick, but with more sensitive ones the falling off is less rapid. There is also some indication of aeolotropic absorption, transmission taking place more readily in the east and west direction than in the north and south; though, in some cases, the reverse is true. The author concludes that it is too soon to draw definite conclusions. However, there appear to be large masses of absorbing material, probably ionized air, in the upper atmosphere. Down near the surface these masses are not continuous, but resemble clouds. In temperate climates the waves do not reach up to the height of the absorbing clouds, and are not absorbed appreciably up to distances of 100 miles. Beyond this the absorption increases at a rate proportional to a higher power than the first of the distance. For long distances the absorption may be very great, less than one-tenth per cent of the energy being received. Sunlight causes the height at which absorption takes place to approach nearer the ground. This is due probably to ionization. In tropical countries the absorption height is less than in temperate climates. The difference between daytime and nighttime absorption is not so great over long distances, suggesting that the action of daylight is to lower the level at which absorption takes place. It is estimated that the height above the earth at which marked absorption takes place is, roughly, 300 miles at night and 100 miles during the day for the temperate zone, and 100 miles at night and thirty miles during the day for the tropics.—*Abstracted from the Electrical Review (London), May 11.*

New Electric Light and Power-Plant of the Mutual Electric Light Company, San Francisco, Cal.

A description is given here of one of the San Francisco power-plants which went through the recent earthquake without suffering much damage. The plant is a new one, and has been in service about a year. The lot available for the building was not altogether suited to the purpose, so that it was necessary to draw plans for placing any future boilers in a second tier above the first. The completed plant will have an output of 9,000 kilowatts, and will contain six 1,500-kilowatt steam dynamos. At the present time two of these units have been placed in service. Much difficulty was met in laying the foundations, as the ground was all filled land, and it was necessary that the floor of the basement be below the sea level. A large number of piles were driven and cut off below the water level. On these piles was placed a concrete layer twelve inches thick, the piles projecting six inches into the concrete. The foundations were built up of concrete on piles and were put in before the floor. It was feared that there might be some difficulty in preserving a tight joint at this point, but this has not been so. To resist the upward push of the water, iron rods were passed through the top of the piles and embedded in the concrete floor. A few cracks did appear in this floor, but were easily stopped. The boiler equipment consists of three Babcock & Wilcox water-tube boilers arranged to provide steam superheated 120 degrees Fahrenheit. The fuel is oil supplied from two large tanks buried beneath the sidewalk. The furnaces are arranged on the Peabody system, in which the bridge wall is placed further away from the front of the boiler than is customary. The burner is installed immediately in front of the bridge wall and throws the flame upward toward the front instead of in the reverse direction. The engines are of the horizontal, cross-compound, condensing type, built by the Pennsylvania Iron Works Company, Philadelphia, Pa., and are guaranteed to develop one indicated horse-power with thirteen and one-half pounds of dry saturated steam per hour at a steam pressure of 145 pounds at the throttle and twenty-six inches of vacuum at the low-pressure cylinder, the speed being ninety revolutions per minute. The generators were built by the Allis-Chalmers Company. They are of the fly-wheel type. Each has eighty poles and delivers current at sixty cycles, 2,250 volts, two-phase. To provide for a small arc light load, three Fort Wayne direct-current arc light generators, driven by induction motors, have been installed. Careful consideration was given to the matter of driving electrically all the auxiliaries of this plant, but in view of the fact that only two of the units were to be installed in the first instance, steam-driven auxiliaries were compulsory. The condensing water is drawn from the bay by means of a twenty-eight-inch cast-iron suction pipe 650 feet long. This is the only part of the system that suffered during the earthquake, with the exception of a small part of an ornamental brick wall extending above the roof of the building. The latter was thrown down and fell directly over the pipe, breaking it in two places and driving the broken section down into the ground two inches. As it was impossible to get a new section of pipe, the broken section was raised into place and surrounded with a layer of cement mortar. This was allowed to set for a short time, and, upon testing with the pumps, it was found to be tight, and the plant was put into service again.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), May.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

ELECTRIC IRONS AS REVENUE PRODUCERS.

BY S. M. KENNEDY.

The problem of building up a day load is one that continually confronts the central station manager. The difficulty of reducing that deadly curve between the "peak" and minimum demand is ever before him, and he should be anxious and willing to adopt every legitimate means of creating a market for energy which will be used during daylight hours. But this market can not be obtained suddenly or without effort, and the demand for day current is not going to begin with leaps and bounds. It must commence gradually, as the result of an educational campaign, and be developed by energy and enterprise. The purport of this paper is to show how electric irons may be used as an entering wedge, and their use continued until the result is a direct benefit to a company in the shape of an important addition to its income.

The Edison Electric Company, of Los Angeles, Cal., has adopted an original plan for stimulating the use of day current in the homes of its consumers. This company operates in some twenty cities—the system being interconnected, and supplied with energy by water-power plants, which, when necessary, are supplemented by steam.

About two years ago a campaign was inaugurated with the object of installing electric irons in laundries for general use, so that the old appliances might be displaced by modern current-consuming devices. Much stubborn opposition was met—it being found a difficult task to convince the laundry men that there could be any decided advantage in making such a radical change. In order to break ground it was necessary to make a considerable number of installations on trial. This plan was adopted with one or two laundries in each city, so that the superiority of electric irons might be demonstrated. Power rates were given for the service—usually about three cents per kilowatt-hour. The results were certainly flattering for the irons, and some of the advantages acknowledged by the laundry owners were as follows:

1. Decrease in cost of operation.
2. Increase in the capacity of ironers.
3. Absence of foul air from gas and other heaters.
4. Workrooms of a comfortable temperature.
5. Saving of time formerly wasted walking to and from stoves.
6. Saving of trouble keeping irons at even heat.

Name	Address
Occupation	Entered on Register by
Owner	Iron Deposit No. / Iron Deposit Refunded

REMARKS

Form C 42—5m—3 06

LOANING AGREEMENT---ELECTRIC LAUNDRY IRON No._____

_____ Cal. _____ 190

TO THE EDISON ELECTRIC CO

The subscriber requests you to loan h an Electric Laundry Iron No._____ Weight lbs. manufactured by Pacific Electric Heating Co., upon the following conditions:

1 Said Iron to be loaned by you for use in premises No._____ St. in Cal., for a period of_____ months from date.

2. In consideration that you will make no rental charge for said Iron, the subscriber agrees to regularly use same on electric service supplied by you.

3 Subscriber agrees to be responsible for all damages to said Iron while in h possession, except reasonable wear and tear, in a sum not to exceed $4.00.

4. Subscriber agrees to return said Iron to you immediately should h cease to have a regular use for it or if h should vacate above premises.

5. This to be accepted by your solicitor provisionally: but to be binding on you only upon its approval by you endorsed hereon by your President or other officer duly authorized by your Board of Directors.

Accepted provisionally
THE EDISON ELECTRIC CO.

By _____

Approved _____

_____ Subscriber

Address _____

"ELECTRIC IRONS AS REVENUE PRODUCERS"—A COPY OF THE LOANING AGREEMENT.

FIVE REASONS

Why You Should Take a Special Interest in

ELECTRIC LAUNDRY IRONS

First.—On or about April 1st, 1906, we will inaugurate a plan whereby all consumers using electric light from this company may have the loan of an Electric Iron—free of charge—upon application at the company's office.

Second.—The price of electric lighting has been reduced, from a base rate of 15 cents per kilowatt to 12 cents per kilowatt, which will mean a corresponding reduction in the cost of using Electric Irons.

Third.—For the warm weather, and in fact for any time, there is no appliance which can give as much convenience and comfort, and save trouble and annoyance, as an Electric Iron in your house.

Fourth.—It may be used in any room where electric light is installed, and may be operated day or night.

Fifth.—While the company cannot afford to carry an account for less than the minimum of $1.00 per month, it wants the consumers to use all the service to which they are entitled for that amount, and believe that consumers may use an iron during several months of each year without any or very little additional expense.

THE EDISON ELECTRIC COMPANY

"ELECTRIC IRONS AS REVENUE PRODUCERS"—THE ANNOUNCEMENT.

7. Cleanly ironing; the face of the iron never touching anything but the work.

8. Choice of best class of workers.

9. Increase of production.

With such advantages once proven, it was a comparatively easy matter to convince all the laundry owners that they absolutely needed electric irons in their business. Now there is no laundry of any importance on the company's extensive system that has not at least a score of electric irons in daily operation.

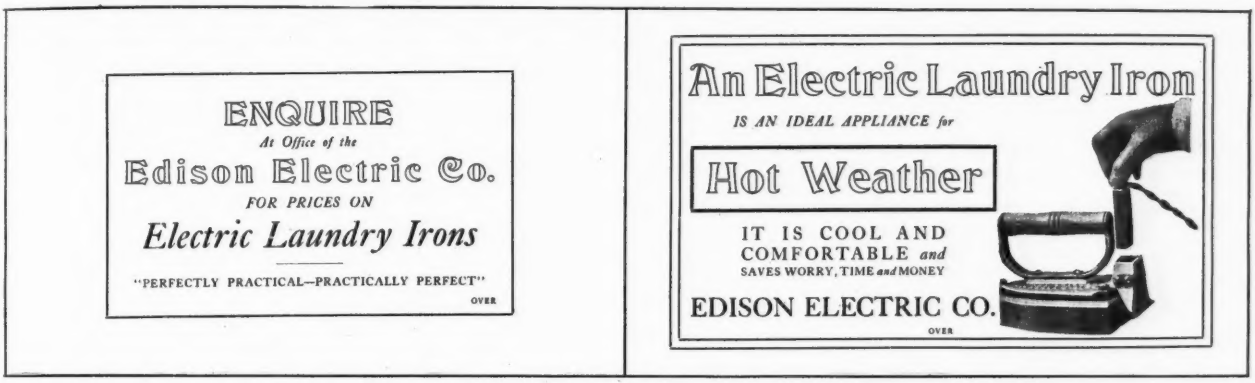
But the Edison Electric Company considered that if electric irons were so beneficial to laundries, why not to individuals? If they could be used with so much profit on a large scale, why not in every home? The company, therefore, commenced advertising the irons extensively among its customers, and put a number of solicitors in the field to sell the appliances to as many as possible who were using electricity for lighting. In about twelve months' time there were sold to consumers over 1,600 electric irons for use in their homes. These sales were made at a small profit, so as to help cover the expense of handling.

For family use the electric iron was found to be a decided success. Its utility, convenience and readiness at all times commended itself to housewives, and in the great majority of cases the expense of operation caused no complaints when monthly bills were presented. Many people also found that the irons could do more than iron, for by means of a diminutive stand they could be turned upside down and converted into little heaters, which were big enough to warm food and boil water. This phase of the appliance was appreciated by families in which there were young children, and also in cases of sickness.

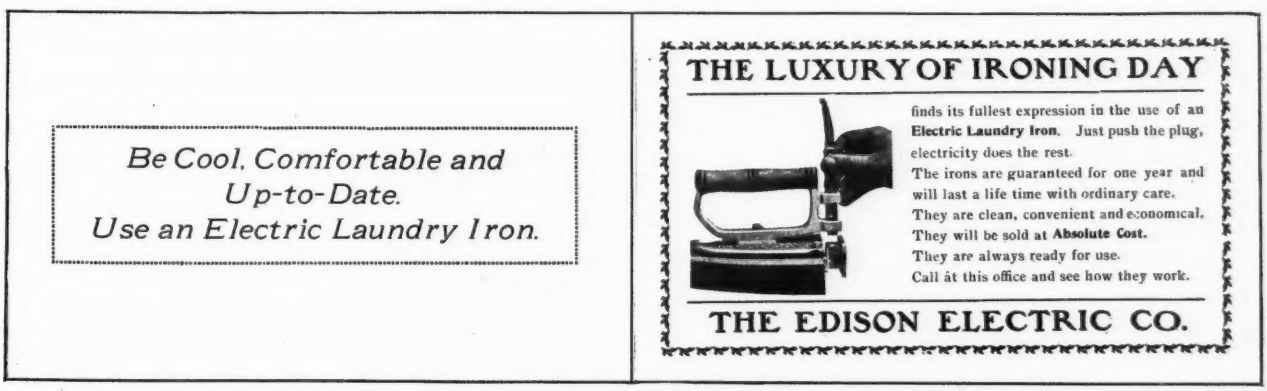
The company kept careful note of results obtained and the data compiled were soon found to be extremely interesting. It was discovered that, figured on a conservative basis, each electric iron in use represented an increase in revenue to the company of sixty-eight cents per month, equal to eight dollars annually. Further, the irons were doing much to popularize the use of electricity and increase enquiry for other electric appliances. The irons being operated almost exclusively in the daytime, the consumption was of necessity adding to the day load, which to a company operating with water power practically meant the finding of so much money. In other words, this was increased income, for current sold at lighting rates, without any additional expense or investment to the company. For, be it known, the same plant, lines, transformers and meters, which were sufficient to take care of the lighting requirements at night, were also sufficient to handle the additional demand put upon them by the use of thousands of electric irons between sunrise and sunset.

But if the use of electric irons had so many advantages for both company and consumers, why not sell more? Why should a company with upward of 30,000 consumers have less than 2,000 electric irons in use?

Just because so many would neither buy nor rent the irons for use in their homes. For every one the Edison Electric Company sold, they found that at least ten people would use the irons if there were no rental or purchase price to pay. The majority of consumers could not or would not part with any money on account of the iron itself, but would be willing to pay for the current consumed in its operation. With the experience already related there was only one thing for the company to do: spend a little money, take a little risk and loan the irons to consumers who would agree to use them. It was easy to obtain a low price on the irons when ordering in large quantities. An income of eight dollars from each iron in use, without any expense or outlay, other than the amount invested in the iron itself, was



"Electric Irons as Revenue Producers"—Used During the Campaign.


Be Cool, Comfortable and
Up-to-Date.
Use an Electric Laundry Iron.
THE LUXURY OF IRONING DAY
finds its fullest expression in the use of an Electric Laundry Iron. Just push the plug, electricity does the rest.
The irons are guaranteed for one year and will last a life time with ordinary care.
They are clean, convenient and economical.
They will be sold at Absolute Cost.
They are always ready for use.
Call at this office and see how they work.
THE EDISON ELECTRIC CO.

"Electric Irons as Revenue Producers"—Two Sides of a Flyer.

too good a proposition for the company to turn down. And, accordingly, the company decided to put into effect a plan which was without precedent.

The first thing was to be sure of the proper make of electric iron—the iron which would be the most efficient and give both the consumer and the company the least amount of trouble. The make which the company had sold almost exclusively was a Western product, and as it had been backed by guarantees, and had stood the test, it was considered good enough for the company to continue with. The first order placed was for 3,500, and this quantity was all distributed to customers in less than sixty days. In fact, after the scheme was properly started, by means of newspaper and other advertising, the demand was greater than the supply. It is now confidently expected that within twelve months from the date the loaning commenced the company will have 10,000 electric irons in use in the homes of its customers. It does not take an expert to figure what such a number of irons will annually yield to the company in dollars and cents.

The indirect effects are also of inestimable value, for each iron thus loaned is assisting in adding to the company's popularity, and further, it is educating the customer as to the greater advantages of electricity and creating a demand for other current-consuming appliances adapted for home use.

The method of loaning the irons is as follows: the company uses a form entitled "Loaning Agreement." This is a request from the consumer for the loan of the iron. It is also a description—giving the number and weight. Further, the subscriber agrees to regularly use the iron, to be responsible for it while in his possession and return it to the company should he cease to have regular use for it, or vacate the premises in which it is loaned. Any property owner who is a customer of the company is entitled to have the use of an iron without further conditions, after he has signed one of these agreements. Any tenant who desires to have the use of one of the irons must put up what is termed an "electric iron deposit." This deposit is only the nominal sum of $2.50 for each iron, and will be refunded to the customer upon the return of the iron in good order and condition.

The liberality of the company in this matter has been much appreciated by the public; and among the company's customers the electric iron has become such a favorite that, after it has been in use for a month in any household, it is generally considered an indispensable article.

THE VALUE OF OPINIONS IN BUSINESS-GETTING.

BY JOHN CRAIG HAMMOND.

There is no good reason why the subject of new business for central stations should ever come to a dispute between experts as to the best methods to be employed.

There is one best way—there are scores of bad ways.

The only way to find the best way is to discuss the questions pro and con, to glean from the great mass of figures and "opinions," the logical one.

The meeting of the National Electric Light Association this month will add to the general knowledge on the subject of new business.

The convention in Denver last year brought to the surface helpful discussion on the merits of advertising.

There are scores of central station men who will attend the convention at Atlantic City with the hope of gleaning more knowledge.

A few days ago I was discussing the merits of the Co-operative Electrical Development Association with its father, J. Robert Crouse.

Now Mr. Crouse, in my humble opinion, is working along sane and logical lines. He has accomplished things that to the average man would have seemed almost impossible. But nothing is impossible to Mr. Crouse, with his bundle of result-bringing nerve and energy.

I think he will work out the scheme to "its logical conclusion," which is a favorite expression of the ex-lamp man. Though Mr. Crouse might be called an ex-lamp man, it's better to call him the father of a scheme that in time will be of the greatest value to the electrical world at large. It will reach from the professor to the manufacturer, from the stockholder to the public. That's the reason Mr. Crouse is going to win—his scheme is a logical one.

"We want harmony," said Mr. Crouse as he held up the corner of a building at Wall and Broadway a few days ago.

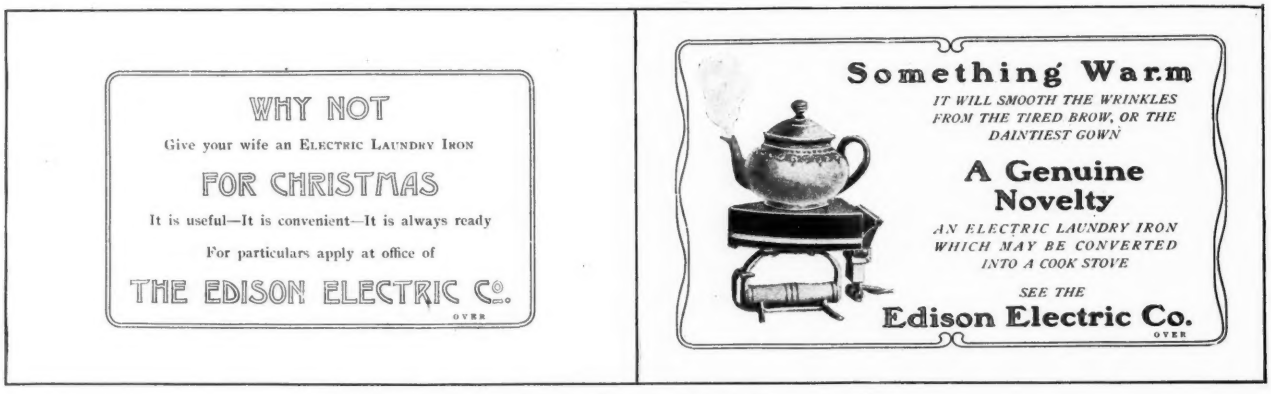
And I nodded assent.

"Granting that you know something about advertising," he went on with a faint smile; "granting for argument sake that you do," driving the point home, "and granting that Lee and the other fellows do—now what I want to do is to get all the experts"—he turned his head away from me—"together and see if we can't agree on one plan."

"Yes?" I questioned.

"We don't want to puzzle the central station man with half a dozen different ways, we want to give him the best way. So if I can get the experts working along one line, then we will have harmony."

Mr. Crouse was good enough to put me in the class with Mr. Lee and others, even though he did not look me straight in the eye. I am going to grab at the straw


WHY NOT
Give your wife an Electric Laundry Iron
FOR CHRISTMAS
It is useful—It is convenient—It is always ready
For particulars apply at office of
THE EDISON ELECTRIC Co.
OVER
Something Warm
IT WILL SMOOTH THE WRINKLES FROM THE TIRED BROW, OR THE DAINTIEST GOWN
A Genuine Novelty
AN ELECTRIC LAUNDRY IRON WHICH MAY BE CONVERTED INTO A COOK STOVE
SEE THE
Edison Electric Co.
OVER
"Electric Irons as Revenue Producers"—A Christmas Suggestion.

and take my place with Messrs. Lee, *et al*, for the time being.

Now I am sure that the best way to bring about the desired results is co-operation. The object of the National Electric Light Association, as I understand it, is to be a helpful organization to its members—to gather different views and ideas on one subject.

Look over the question box as prepared by Editor Lupke this year.

I will guess that you won't find all the same answers to question K 13: "Has experience ever shown that the end-play device on a rotary transformer is beneficial to the wear on the commutator?" I haven't the slightest idea in the world what that question means—a question selected at random from the question box. I don't think experts will agree on all questions of advertising.

They should—there is no good reason why they should not.

There is the only way—the best way. I may know the best way—I may not. I have my ideas; I know from past experience what certain things have accomplished—what has failed in the securing of new business.

Others have their ideas—their experience. When these data are all collected, complied in intelligent systems—then the central station manager is going to be helped—the National Electric Light Association will be accomplishing great good.

A start must be made. It has been made, and the progress has been wonderful.

But we must have discussion—there must be a clearing house of ideas, views and opinions. The grave danger to the central station manager lies in the fact that he might accept my views as being right—when if he would have given them a closer study, applied the conditions under which I have worked for central stations, they might not apply to his needs at all.

Now I take the sweeping position that programme advertising is folly—is a waste of money—will not bring the results. There are experts who will not agree with me.

Am I right—is the other man right?

How are you going to find out? Simply by discussion, by getting down to figures—taking facts, and facts only.

I was talking with the New York manager of one of the great advertising companies. I listened to his discussion of different points and I did not agree with him on one. Nerve? Yes, but it makes the point I want to make: There's no law compelling you to agree with experts. Think for yourself—have the nerve not to agree if you don't see it the same way the expert sees it. You will learn something if you do.

There is only one conclusion that I can see and I want to disagree with Brother Crouse for a second: differences of opinion must be considered. The central station manager must not be frightened at the differences of opinion.

I would advise every central station manager who attends the convention to weigh the discussion on advertising and new business methods with care. Let him read the questions and answers in the question box—let him go home with his data and think conditions over before jumping to any conclusion.

I am confident that by the time the next convention meets—the disputes will have been simmered down to figures. In the meantime let the disputes and discussion, views and ideas go on—it will clear the way to a profitable end.

THE LESSON OF A NEW BUSINESS CAMPAIGN.

BY HOWARD S. KNOWLTON.

Within the last few months the opinion has been expressed in some quarters that the present tendency of central stations to spend considerable sums of money and much valuable time in the organized search for new business is likely to be greatly overdone before the full benefit of the campaign is enjoyed. It is stated that it is better to devote one's energies to the economical operation of the present equipment; to make every effort to satisfy present customers before endeavoring to secure more customers than the company's present equipment can supply with good service, and to add to the total connected load by steady rather than forced growth. New business efforts, according to this viewpoint, should be more or less casual, depending particularly upon the personal equation of the central station manager at the psychological moment when the prospective customer can best be approached.

Doubtless there is considerable wisdom in the conservative attitude outlined above, but we believe that the conditions under which modern central station work is carried forward do not admit of a policy which swings to the extreme of having nothing to do with organized efforts to obtain new business. There never has been a time when public service corporations have been subjected to as close scrutiny as they are to-day; the fallacies of municipal ownership have yet to be brought home to thousands of well-meaning but uninformed consumers of central station current; the competition of gas in lighting, heating and power service is unusually close, and in some localities the attitude of the press toward various will-o-the-wisp propositions in the form of suggested competition in restraint of so-called monopoly is far from pleasing. I believe that every central station should strengthen its list of satisfied customers, and am convinced that a moderate expenditure for this purpose is thoroughly justifiable. In this connection it is interesting to compare the results obtained in two neighboring stations in the same state, one of which, station A, has done little or nothing in the way of organized new business getting, while the other, station B, has made large effort to increase its connected load along the lines which are so generally being practiced to-day by those who favor organized advertising in the central station field.

Station A serves a city community of considerably over 100,000 inhabitants, while B serves about two-thirds this urban population. The gross earnings per capita in the last fiscal year for A were $2.28 and for B $3.96. Each city is an important manufacturing, educational and residential centre, so that the standards of living in the two communities are essentially similar. Yet in the smaller city we find seventy-four per cent more money per capita expended for electric light and power service. Again, station A has less than half as much connected motor horsepower as B, the figures being 1,126 horsepower for A and 3,335 for B. In other words, the motor horse-power per 1,000 inhabitants is 8.8 in the city which has paid little attention to organized new business methods and 38.5 in the other community. The lighting rates in each city are very similar, but the minimum power rate in the smaller community is much lower than in the case of station A. Each company has about the same total number of 16-candle-power incandescents connected—68,000. Station A has one incandescent to every 1.9 people, while B has one to every 1.3, approximately. Station A increased its connected motor load 4.9 per cent in the last year, whereas B's motor load increased forty-five per cent. It would be unfair to charge this difference entirely to the new business methods of B, for doubtless the latter's minimum power rate of two cents per kilowatt-hour in comparison with A's six cents, minimum, accounts in considerable measure for the discrepancy. The extremely low rate of B is made possible by the location of one of the company's plants on a sub-

stantial water power—an advantage which station A in no sense enjoys. In the matter of operating cost, company A's ratio of expenses to receipts is only forty-nine per cent, against sixty-four per cent for B. In the production and distribution of power station A has few equals in the state in which it is located, despite station B's water power facilities. Each company paid eight per cent dividends in the last fiscal year.

The lesson of station B's new business campaign seems to be plain from the above figures, which are presented simply to show the desirability of looking pretty thoroughly into the subject of new business work before concluding that the game is not worth the candle. Certainly the density of electric light and power service is in this case greater with the city whose central station company has paid the most attention to exhibiting new appliances in the centre of the community and to organized methods of solicitation.

Electric Plant Concessions in Colombia.

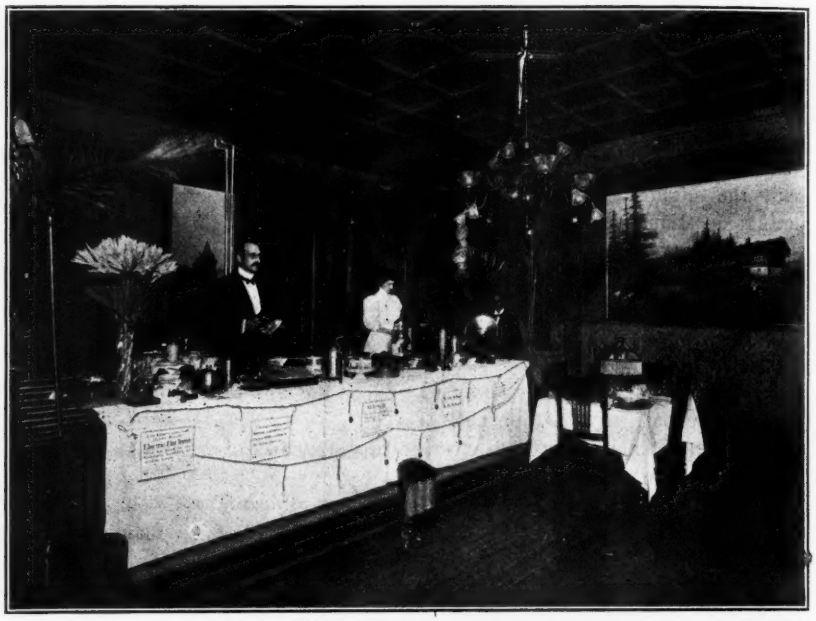
Consul P. P. Demers, of Barranquilla, forwards translated copies of a Colombian government concession given to Francisco E. Baena, president of the Barranquilla tramway, prolonging for thirty-nine years a previous concession for the building and operating of an extensive tramway.

The new concession includes the obligation to put into service modern cars, substitute electric traction for that of animals, and to extend the lines to Soledad and Sabanalarga. Barranquilla has about 50,000 inhabitants, having gained 30,000 in the last twenty years. Soledad and Sabanalarga are respectively six and thirty-six miles distant from Barranquilla, between which there is extensive cart and mule-back traffic over hot sandy roads. The tram company has also been granted an electric light franchise. The concession is of interest, it being the intention of Mr. Baena to develop the enterprise with American capital and equip the whole service with American cars and machinery. Copies of the concession can be seen at the Bureau of Manufacturers.

The successful establishment in Colombia of a modern trolley and electric light system under American management and capital will be a good step toward the introduction of American commerce there. To-day there is practically nothing American in the Barranquilla district except the ownership of a few outlying mining industries in adjacent states.

Lecture on Electrical Heating and Cooking.

On the evening of April 27 a lecture was delivered by Mr. Max Loewenthal, E.E., vice-president of the New York Electrical Society, before the Stevens Club, of Newark, N. J., on "Household Uses of Electricity," with special reference to electric cooking and heating. As will be seen from the picture, a great variety of cooking and heating utensils and other domestic current using appliances were displayed on a table set on a platform.



Display of Electric Heating and Cooking Apparatus, at Lecture Before Stevens Club, Newark, N. J.

Mr. Loewenthal sketched in a few words the development of the electric heating industry and the relation of this branch of the electrical engineering to others with which the public is better acquainted, and showed, by a number of interesting experiments, the great utility and economy of the devices which were exhibited.

During the course of the lecture Mrs. Loewenthal prepared on the electric cooking utensils, a complete meal, which was served on a small table stationed in the front of the platform, to a number of those present.

Before and after the lecture vocal selections were rendered by the Stevens Quartette. It was near midnight when this very interesting and entertaining affair came to a close.

The United Electric Company, of New Jersey, not only placed at the disposal of the club all the utensils exhibited by the lecturer, but also furnished all the wiring from the nearest outlet to the various switches at the table and had special leaflets prepared, which were distributed during the evening.

United Railways Rebuilding.

According to reports received by the United Railways Investment Company, which controls the San Francisco traction lines, more than 2,000 men are now employed on reconstruction work. The company has secured a franchise for electric lines in place of the old cable franchises and the road will be equipped with overhead trolley wires as rapidly as possible, the intention of the company being to electrify virtually the whole system.

Less than 101 cars out of a total of 1,000 were destroyed by the fire. The total losses are now estimated at $1,250,000. Earnings from the portion of the road in operation are sufficient now to meet the fixed charges and one-half the preferred dividend requirements.

Electric Plant Contract for Leon, Nicaragua.

Vice-Consul A. O. Wallace, of Managua, reports that the city of Leon, Nicaragua, has given an electric light and power plant contract to René John La Villebouvre, an American residing at Managua. The city takes 100 arc lights of 1,200 candle-power each, and absolves the contractor from all taxes, gives him the free use of any municipal lands and all the building material for construction; also guarantees to obtain free of duty the importation of all needed machinery and tools for thirty years—the life of the contract. The plant is to be installed within eighteen months, and to be sold to the highest bidder at the end of the thirty years' term.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Evolution in Size of Transformer Units.

Heretofore the power developed by large generating units, whether steam or water driven, has been delivered to several step-up transformers to transmit the total energy at an increased voltage, and, in the same manner, the transmitted power has been stepped down to the proper operating potential at the receiving end of the line. Recently, however, a method of building large transformers has been devised by which an enormous amount of power may be transformed in a single unit. Such designs embody principles of

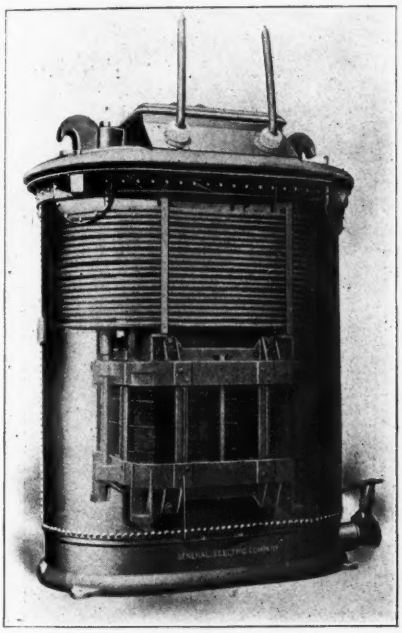


FIG. 1. — TRANSPARENT VIEW OF A 2,000-KILOWATT, WATER-COOLED, OIL-IMMERSED TRANSFORMER.

insulation for high potentials and various methods of maintaining a low operating temperature by artificial cooling of the insulating medium. To make the following description clear, therefore, a brief résumé of the methods of cooling transformers is of importance.

With the earlier smaller, lower voltage units a proper allowance of space for the natural circulation of air sufficed for both cooling and ventilation; but with increased voltages and deeper windings, oil came to be used for an insulating and cooling medium, the natural circulation carrying the heat away from the windings. These two forms of insulation and ventilation were next improved by circulating the air by motor-driven fans—as in the air-blast type of transformer—and by introducing water-cooling coils in the oil-immersed types. The new method of cooling is a still further development of the water-cooled, oil-immersed type of transformer.

The water-cooled, oil-insulated transformer (see Fig. 1) was developed in order to provide the necessary insulation and cooling for large high-tension units without making the transformers as large as would have been necessary if they had been designed on the self-cooling, oil-immersed plan. In the water-cooled, oil-immersed transformer the oil is set into continuous circulation by the cooling effect of a water coil, placed in the top of the transformer tank; the heated oil rising through ducts provided in the iron and copper structure of the transformers gives up its heat to the water coil and descends between the transformer and the walls of the tank. The induced circulation of the oil, thus effected, secures high cooling efficiency of the oil in this transformer.

In the newly-developed transformer the oil is pumped through ducts in the windings and core from an outside source. With such a scheme transformers can be built of much larger capacities than the largest existing water-cooled transformers of the ordinary type without such increase in size as to show a prohibitive cost and to necessitate shipment of the transformers in parts for erection at the place of installation. The forced oil design allows the circulation of the oil to be increased to any desired extent, thereby procuring a rapid and positive circulation which greatly increases the cooling efficiency of the oil. The forced oil circulation is accomplished by taking the heated oil out of the transformer tank and effecting the cooling in an "external circuit" comprising an oil cooler, pump and reservoir, as shown in the accompanying diagram, Fig. 2, thereby effecting marked reduction of size and weight of the transformer tank, of space required for oil between the transformer structure and the tank, and of the amount of oil itself. In the diagram the reservoir serves to give a head for the oil, and pumps are provided for water and oil which flow in the directions shown by the arrows. To prevent water from entering the oil from any accidental leak which might develop in the piping or joints, the cooler is placed on the pressure side of the oil pump and on the suction side of the water pump. In hydroelectric installations the cooling water is taken from and returned to the tail-race. The new design thus compares with the ordinary water-cooled, oil-immersed transformer very much as the air-blast type compares with the old self-cooled transformers.

The use of a pump and reservoir in the oil-circulating system gives better control of the oil circulation in the forced oil transformer than in the water-cooled type; and the heating is readily held within the limit of a thirty-five degrees temperature rise for continuous full-load operation. Moreover, this method of oil circulation ensures such uniform and positive cooling that much higher indicated temperatures may safely be permitted in trans-

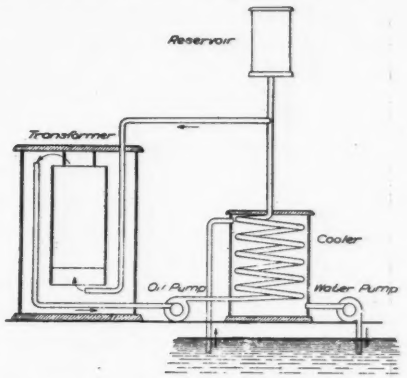


FIG. 2.—DIAGRAM OF OIL-COOLING ARRANGEMENT IN GREAT NORTHERN TRANSFORMER.

formers operating at moderate overloads. With ample capacity provided in oil and water-circulating pumps, the transformer can without danger be called upon to carry extreme overloads under emergency conditions.

Six units of the forced oil type of transformer have recently been built by the General Electric Company for the Great Northern Power Company, Duluth, Minn., designed for a nominal capacity of 7,500 kilowatts at twenty-five cycles, three-phase, but actually capable of carrying 10,000 kilowatts continuously at a safe temperature. The high-tension windings are adapted for 30,000 or 60,000 volts and the low-tension windings for 6,600 or 13,200 volts. Three of these transformers are to be installed in the main generating station, the ultimate layout of which will call for eight units, to be supplied with

current by eight 7,500-kilowatt General Electric generators. The other three transformers will be installed in the Duluth substation, the ultimate layout of which will comprise four units.

Fig. 3 gives an idea of the appearance of the high-voltage side of the transformer, and the comparison in size between a 0.6-kilowatt transformer, a man and the 7,500-kilowatt unit. Fig. 4 shows the transformer removed from the tank, with the low-voltage terminals in front.

For the reasons set forth the new transformers are more economical in weight of active transformer material, tank and oil, and in space occupied, than they would be if they were designed with an internal water coil depended upon to induce a circulation in the cooling oil. At the same time transformers of such very large capacity are necessarily much larger and heavier than any transformers that have been built up to present date. The Great Northern Company transformers are fourteen feet ten inches high, fourteen feet long and five feet ten inches wide, and certain structural details, which before have not been taken into particular account, have therefore required special attention.

Owing to the great weight of active material in each transformer (about sixty-five tons) the supporting structure follows the principles of bridge design, and the transformer is supported, clear from the bottom of the tank, from the cast-iron cover. In this way, for convenience of inspection and installation, the cover and active material can be lifted as a unit from the containing tank.

The 7,500-kilowatt units above described are of the three-phase type. It is interesting to bear in mind that a three-phase unit sells for less than the same capacity of single-phase units, and where the installation contains several three-phase units the saving effected will often pay for an additional spare transformer. Whether the installation consists of one or more transformers, one oil cooler, reservoir and set of pumps suffices for the entire installation.

The capacity of each of these units represents by far the largest amount of power ever handled by a single transformer. Ten years ago 750 kilowatts was considered a large size for a transformer. The passage of a decade has thus marked a tenfold increase in the size of this particular piece of electrical apparatus—an advance which is typical of the progress made in electrical science during that short span of years.

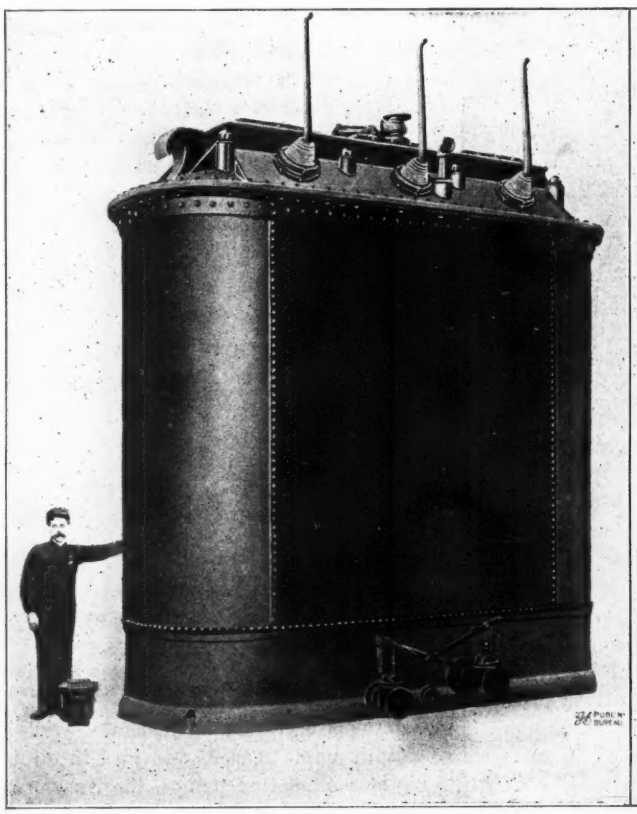


Fig 3.—High-Voltage Side of Great Northern Transformer.

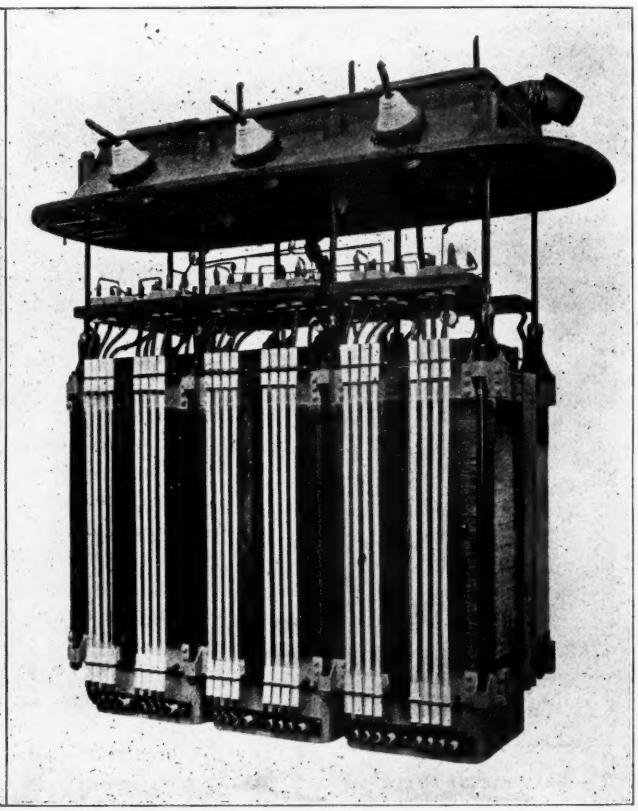


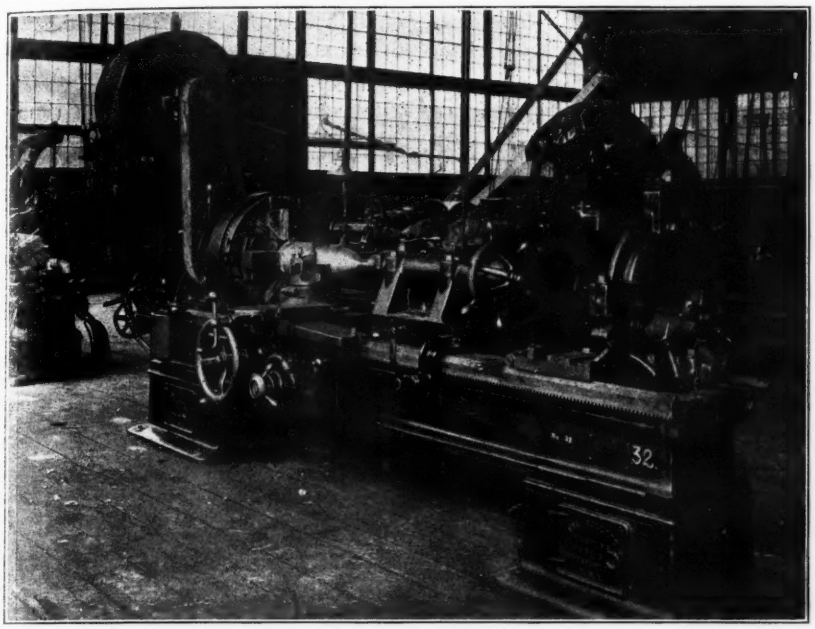
Fig. 4.—7,500-Kilowatt Transformer Coils and Core Removed from Containing Tank and Cover.

Electrical Equipment of Machine Tools in the Plant of the Firth-Sterling Steel Company.

Of the many improvements in manufacturing methods within the last decade there is no one feature that has aided the advancement of machine tool drive by electric motors more than the rapid development of high-speed tool steel for use with metal-working machinery.

A very few years ago, when "high-carbon" tool steel was in use generally, a cutting speed of twelve feet per minute was a fair average, and the cumbersome mechanical speed-changing devices were ample to fulfil the requirements at that time. As cutting speeds increased with the development of "Mushet" and air-hardened tool steel, machine requirements became more severe; and with the advent of high-speed tool steel the machinery of the past was found to be too light to meet the more severe requirements of increased output that followed increased speed, and heavier machinery was placed in operation. As a consequence the problem of transmitting power became more important as the use of belting and shafting became more wasteful and costly with higher speeds and increased power demands; and, further, the time and labor

spent in shifting heavy belts to the various steps of cone pulleys seriously hindered the efficient operation of machines. The logical sequence was the introduction of the electric motor for individual driving of machine tools.



TURNING A SEVEN-INCH PROJECTILE. TEN-HORSE-POWER MOTOR. FIRTH-STERLING STEEL COMPANY, DEMMLER, PA.

Then came the problem of providing a reliable and efficient means of controlling the speed of the motor.

From about twelve feet per minute the cutting speed of machine tools increased to about fifty feet for roughing cuts on steel and from eighty-five to 125 feet per minute for finishing cuts. This greatly increased cutting speed necessitated perfect control of the motor, so that the machine speed could be varied with each change of diameter of the work in order that full advantage of the improved conditions might be realized.

Many methods of control were advocated and used. Although some of the systems met the speed requirements, they were costly and complicated and left a large field for improvement. As motor-driven machinery had demonstrated its greatly increased efficiency over the older methods of transmitting power, it only remained to produce a thoroughly simple and reliable means of controlling the motor speed.

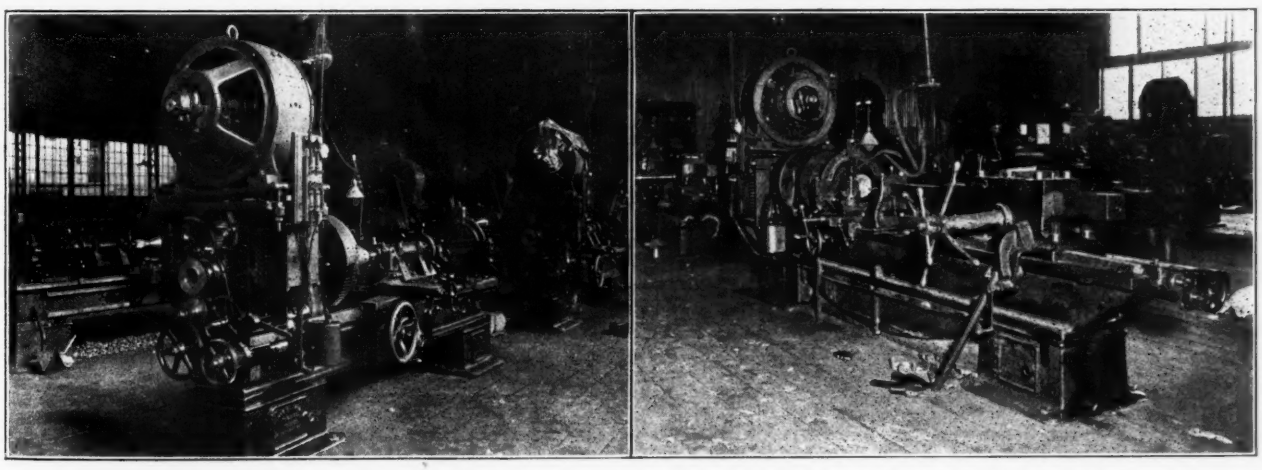
To meet the demands of such service the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., developed a new line of direct-current motors, known as the type SA, with a speed range of four to one on a single voltage. The control of this wide speed is obtained by introducing resistance in series with the shunt field coils.

Both mechanically and electrically the type SA motors are identical in construction with the well-known type S motors, with the exception of auxiliary poles and coils. This new feature has been introduced to control the field form during the variation of field strength necessary to secure so wide a range of speed.

The auxiliary poles are bolted securely to the frame midway between adjacent main poles. The winding of the auxiliary poles is connected in series with the armature and produces a magnetizing effect which is proportional to the armature current. This introduces a factor which compensates for the distortion caused by armature reaction and field weakening. In ordinary motors the effect of armature reaction is to shift the path of the magnetic flux, weakening the leading pole tips and, consequently, shifting the neutral point, necessitating a backward lead of the brushes to obtain a field for sparkless commutation. By introducing the auxiliary poles a commutating field is maintained in a fixed position regardless of load or direction of rotation.

The practical application of the SA motors is illustrated by a typical installation in the new projectile shop of the Firth-Sterling Steel Company, at Demmler, Pa.

Before adopting the Westinghouse equipment this company made exhaustive investigation of various methods of machine tool drive, both mechanical and electrical. A number of features had to be taken into consideration as, theoretically, the cutting speed of machine tools does not have to be varied—changing the feed and depth of cut to suit the various diameters of the work only being necessary.



TEN-HORSE-POWER MOTOR OPERATING A TWENTY-SIX-INCH SWING LATHE, AND FIFTEEN-HORSE-POWER MOTOR DRIVING HORIZONTAL BORING MILL, FIRTH-STERLING STEEL COMPANY, DEMMLER, PA.

Following out this theory, five-step cone pulleys were reduced to two steps, and a much wider belt was used to drive the machines, owing to the increased power requirements. This method did not give satisfaction in practice and was soon abandoned.

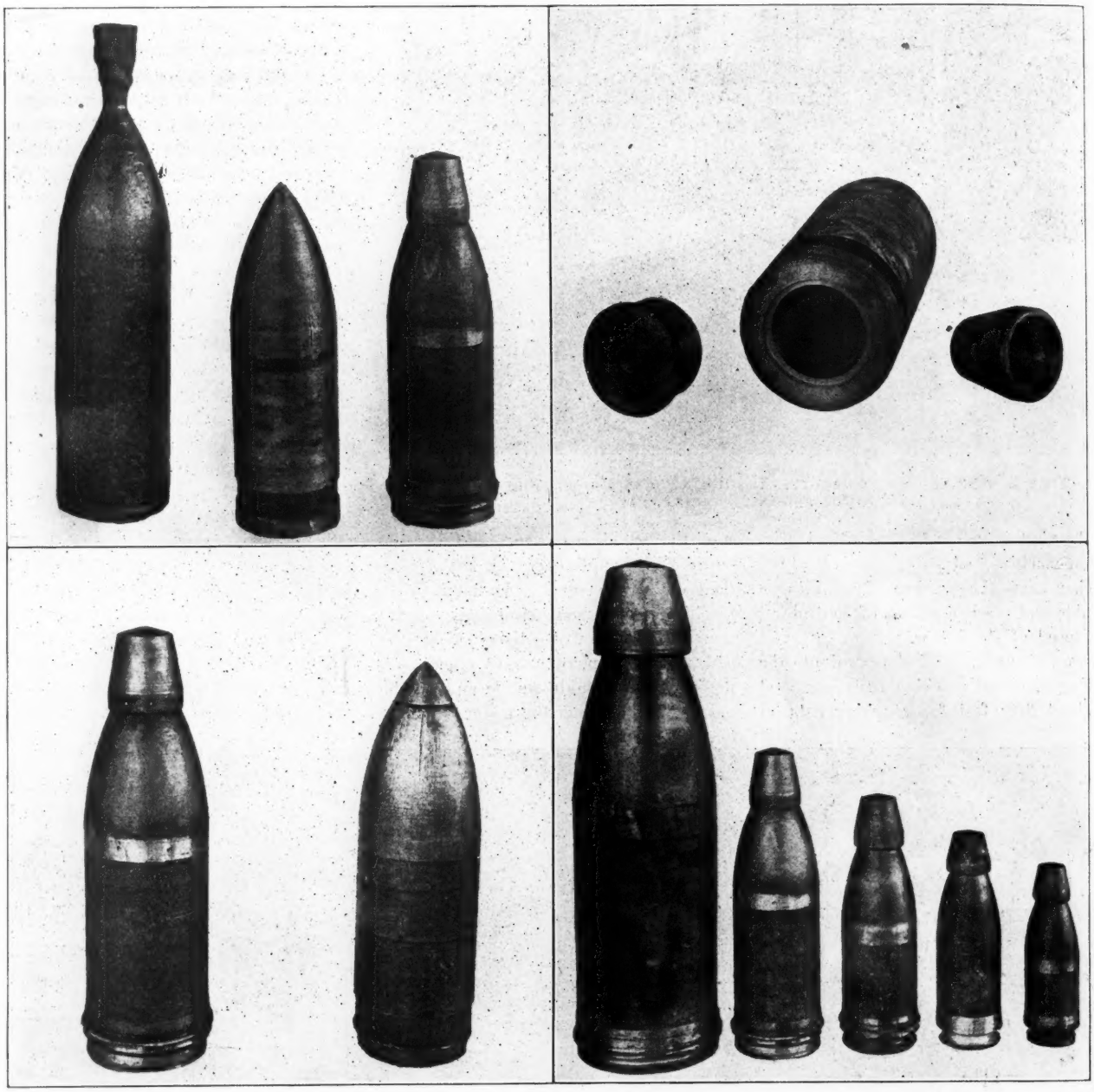
The multivoltage system of motor drive was next investigated, but did not meet with favor, and the Westinghouse type SA motors were adopted and have clearly shown their greatly increased efficiency over belt drive, giving entire satisfaction in every respect.

The equipment consists of eight ten-horse-power type SA motors driving eight twenty-six-inch swing Bullard lathes, two fifteen-horse-power type SA motors, each driving a Bullard horizontal boring machine, and one seven and one-half-horse-power type SA motor direct connected to a Bullard turret lathe. The speed of the motors is varied by controllers with twenty-one notches, giving twenty-one motor speeds.

In addition to the SA motors there is a thirty-five-horse-power type S constant-speed motor belted to a line shaft which furnishes power to a group of small machines, including a planer, cutting-off machine, centering machine and two drill presses.

By following the various steps in the manufacture of projectiles, the adaptability of variable-speed motors to this class of work is clearly apparent. The motor-driven machines are not confined to such work in the Firth-Sterling plant, however, as various kinds of machine products are turned out as well, the wide range of speed and ease of control being especially adapted to the testing of high-speed tool steel.

A novel method of checking the efficiency of employés has been introduced by



1—Projectile in the Rough, Turned, and Fitted with Cap and Plug. 2—Projectile, Cap and Plug. 3—Complete Ten-Inch Projectile and Projectile After Piercing Ten-Inch Armor Plate. 4—Various Sizes of Armor-Piercing Projectiles.

the Firth-Sterling company, which is made possible by the use of electrically driven machinery. It consists of placing, in a convenient location for observation, a recording ammeter arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work, so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle.

By referring to the illustrations a good idea of the appearance of projectiles in the different stages of manufacture can be gained, but to give a clear understanding of the operations necessary to complete work in this important branch of the steel industry a description of the various operations is given.

The first step is the making of a steel casting similar in form to the finished projectile, but somewhat larger in diameter. After the metal has congealed it is removed from the mould and allowed to cool. The casting is then heated to a forging temperature and forged by a Bement-Niles steam hammer, when, after cooling, it is again brought to a red heat and placed in a receptacle and covered with lime and allowed to remain until entirely cool, the length of time depending upon the size of the forging. This is known as the annealing process.

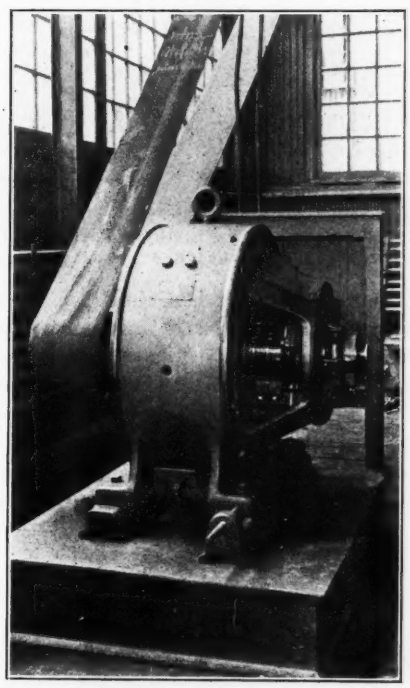
After annealing the forging is taken to the machine shop and the projection on the small end centered in a centering machine. It is then transferred to a lathe, the butt end being chucked and the small end supported by the centre in the tail stock. The machining is begun at the point of the projectile, the lathe speed being decreased with the increase of diameter by varying the motor speed, which illustrates one of the many phases of machine work where variable-speed motors are exceedingly valuable, the operator being able to gauge the proper speed by watching the color of the chip.

After the lathe work is finished the partially completed projectile is placed in a cutting-off machine, and the unfinished end that is clamped in the chuck removed. The work is then transferred to a horizontal boring machine where the recess or chamber for the explosive is bored out. The chamber is threaded near the butt to receive a plug, in the centre of which is a smaller plug through which the fuse is inserted that is ignited by the firing charge and communicates with the explosive at a predetermined time interval, causing the projectile to burst after entering the object at which it was directed.

At two points on the barrel of the projectile the diameter corresponds to the bore of the gun and at a third point near the large end a groove is cut in the barrel into which a copper band is hammered, which, when finished, is slightly larger in diameter than the bore, causing it to engage in the rifleing, giving the projectile a rotary motion.

A groove at the butt provides a means for removing the projectile if for any reason it is not discharged after being placed in the gun.

The point of the projectiles is covered by a soft steel cap which, in some manner not thoroughly understood, enables the projectile to penetrate the plate with much



THIRTY-FIVE-HORSE-POWER, 220-VOLT MOTOR, DRIVING GROUP OF SMALL MACHINES, FIRTH-STERLING STEEL COMPANY, DEMMLER, PA.

lower velocities than are required with uncapped shells.

The cap is held in place by wire driven into a recess formed by the coincidence of a groove cut in the interior with that of a groove cut on the point of the projectile. The treating or hardening process to which the projectiles are subjected after machining is not made public.

The opportunity of comparing the relative outputs of similar machines performing the same class of work in the same manufacturing plant rarely presents itself in as forcible a manner as in the Firth-Sterling plant. The old projectile shop still uses belt-driven lathes, some with wide belts. These belt-driven lathes are the same type of machines as the motor-driven lathes, and the result of some very interesting tests of the number of projectiles finished in ten hours shows the greatly increased efficiency of motor-driven machines.

Diameter of projectile	6″	7″	8″
Number of projectiles finished in ten hours, motor-driven lathe	38	32	25
Number of projectiles finished in ten hours, belt-driven lathe	27	21	17
Per cent increase	40.7	52.3	47

Average increase in output..46.6 per cent.

The belt-driven lathes will eventually be changed to motor drive, which is accomplished by adding an inexpensive mounting for the motor. The shop with the motor-driven machines presents a clean and light appearance; the absence of belting, with the exception of that driving the group of small machines, is a noticeable feature which naturally aids in cleanliness and gives unobstructed light, both natural and artificial.

Pignolet Switchboard Instruments.

Louis N. Pignolet, 78 Cortlandt street, New York city, has recently placed on the market a switchboard voltmeter and ammeter especially adapted to installations where space is limited. These meters are five inches in diameter and one and one-half inches deep. They are furnished in various readings up to 150 volts and fifty amperes. The case is provided with a sheet metal cover finished in polished nickel. The instruments are simple, yet attractive in design. Other finishes may be furnished upon order.

NEW SWITCHBOARD INSTRUMENT.

These instruments are fastened to the switchboard by two bolts which are provided on the back of each meter, and which also serve to convey the current, so that but two holes are required in the board.

The instruments are of the permanent magnet type, thus securing the high accuracy and even scale divisions of this class. The magnets are of imported special steel carefully treated to ensure permanency.

The principle of operation is as follows:

an iron armature is pivoted between the poles of each magnet and is provided with an aluminum pointer which is kept at zero on the scale, when no current is flowing through the instrument, by the attraction of the magnet upon the armature.

The current to be measured passes through a coil of wire located between the poles of the magnet and produces a magnetic field at right angles to that of the magnet. This field causes the armature to turn and produces a greater or less deflection of the pointer according to the strength of the current passing through the coils.

Some Specialties Made by the Loew Manufacturing Company.

The accompanying illustrations show several specialties made by the Loew Manufacturing Company, Cleveland, Ohio. Fig. 1 shows a portable pipe-threading machine. This is solidly constructed and

FIG. 1.—PORTABLE PIPE MACHINE ON STAND.

is designed to resist rough usage. It is, however, made sufficiently light in weight so that it is conveniently portable. For power purposes a direct-connected, three-step pulley and shaft are furnished, also a countershaft carrying a three-step pulley. Power is transmitted by a multiple lead worm equipped with ball-bearing thrust collars. The worm gear has been found to be more powerful than bevel gears, and the addition of the ball-bearing collars increases the power.

The dies, which consist of four pieces, are made of high-grade die steel, and when dull can be reground.

The face-plate adjusts the dies, which engage in a continuous scroll on the back of the plate. The die head is so designed that when the dies are in place and the

FIG. 2.—CLOSED TYPE, SIX-PASS FEED-WATER HEATER.

pressure of the pipe is against them they become self-locking, and it is impossible for them to slip. Each machine is equipped with a four-legged stand, oil pan and tool shelf, and an automatic device for releasing the dies after the thread is cut.

Fig. 2 shows the closed six-pass type feed-water heater. This heater has been designed with a view to securing for the boiler feed water the highest possible tem-

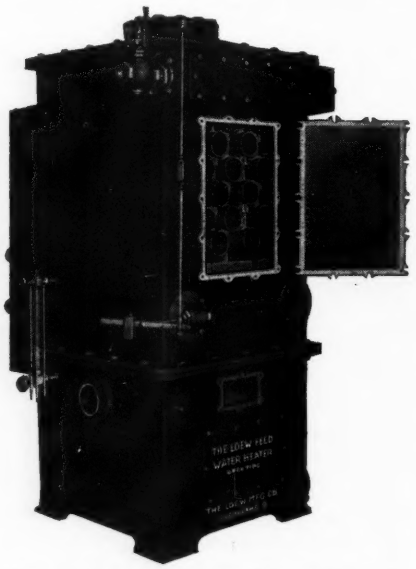


FIG. 3.—OPEN TYPE FEED-WATER HEATER AND PURIFIER.

perature in the shortest time and smallest space. This is accomplished by the arrangement of the water tubes in groups and the rapid circulation of the water, so that it has six passages through the exhaust steam over the entire length of the apparatus before passing to the boiler. At the top and bottom of each section of tubes there is a port which directs the course of the water into the next section, and so on through the heater.

The apparatus is durably constructed of heavy cast-iron and brass. The outer shell, legs and caps are of cast-iron. The tubes are of straight seamless brass. Both ends of the tubes are rolled into tube plates, the bottom tube plate being bolted to the casing at the bottom of the heater, making it stationary. The top tube plate is loose and free from the outer shell, allowing the tubes to expand and contract at will.

The exhaust steam enters the steam inlet, and during its passage to the steam outlet at the opposite side of the apparatus completely fills the shell. The cold water is admitted to the first series of tubes from the water inlet and flows to the port at the top of the apparatus, where it is diverted to the next group of tubes. This course is continued through the various groups until the water has made six passages through the exhaust steam.

This heater is provided with mud blow-offs at the bottom. The bonnets or caps at the top of the heater are easily removed, and the bottom section dropped to the floor. This leaves an open surface of the tubes for cleaning.

Fig. 3 is an open type feed-water heater. The water enters the heater through a balance valve operated by a float, going to a manifold for distribution through a series of pipes which are open on the top. The water overflows in a thin film down the sides of a series of copper tubes into a storage chamber directly beneath, and then flows downward through an open section at the side of the heater to a second storage chamber at the bottom of the heater. The second storage chamber is directly beneath the filter bed, and the water then flows upward through the filter bed into a third storage or outlet chamber, where the pump suction is located. This outlet chamber is entirely surrounded by hot water, thus keeping the feed water at the highest temperature before passing to the boiler.

The exhaust steam enters the heater through a specially constructed oil separator, which effectually separates all the oil and grease from the water. After leaving the separator the steam circulates on the outside and inside of the tubes and comes into direct contact with the water traveling over the outside surface of the tubes.

The heater is made of cast iron, copper

and brass. The tubes are constructed of copper, are rigidly hung so as to ensure against vibration, and are easily removed either singly or in sections. The hangers supporting the tubes are of cast brass and are not affected by corrosion.

The oil separator is constructed of V-shaped iron baffle bars staggered in four rows, set at an angle of about twelve degrees. The oncoming steam continuously drives the collected oil down into the float box out of reach of the passing steam.

A Method of Conveying Steam Underground.

Some interesting work has in recent years been undertaken in the transmission of steam and hot water underground. This undertaking is often attended with a very considerable loss of heat carried by radiation into the ground.

The H. W. Johns-Manville Company is placing on the market and installing sectional tile pipe conduit, which meets, it is said, a long felt want in providing a conduit for pipes running underground which

NEW METHOD OF INSULATING STEAM PIPES FOR UNDERGROUND SERVICE.

should thoroughly insulate and protect the pipes, and which could be installed for a reasonable cost. This is known as the "J-M" Portland sectional conduit, and consists of tile pipe made in top and bottom sections; this division being made by cutting half through the shell of the pipe before it is baked, and then breaking afterward, so that the joint is very much like that made in replacing pieces of a broken plate, the use of neat hydraulic cement making it possible to put these sections together when desired, making practically a perfect looking piece again. As the top and bottom sections are numbered to correspond the same sections can always be mated, and thus a perfect joint is secured.

The support of the enclosed pipes is accomplished by supporting tee sections which are placed in the line of conduit from twelve to eighteen feet apart, depending upon the size of pipes enclosed. This supporting tee section is placed firmly on a bed of concrete which is carried up into the supporting tee section, the concrete holding the metal roll frame carrying the rods and rolls upon which the pipes rest, thus the entire weight of the pipes and their contents is entirely independent of the conduit itself, and it is so firm as to permit of any required weight and movement of the pipes without any injury to the conduit.

The conduit with supporting tees and roll frames are laid section by section until a line is completed, and then the pipes are put in place and tested, after which the insulation may be applied. This insulation may be of either the sectional pipe-covering form, or what is more used is the asbestos sponge conduit filling, with which the entire remaining space in the conduit above the pipes is filled. This insulation is applied while the top sections of the conduit are applied length by length.

It is customary to place under this conduit an underdrain to remove the surplus water, which would otherwise lay against the conduit and absorb the heat.

It has been found that if desirable to open the conduit after the installation is complete this is readily done. Certain features of this conduit are especially meritorious. The simplicity of the system is due to its few parts: each part being designed for its particular function. The pipes may be installed very easily, and the insulation may be easily applied.

With proper care in laying the conduit is said to be practically watertight, and the cost of maintenance is nothing, no repairs being required by the conduit.

The conduit provides for the greatest efficiency possible in the transmission of steam or hot water underground, because of the thorough protection given to the pipes, and the highly efficient system of insulation provided.

An "Indestructible" Flat-Iron.

It is probable that many odd electrical coincidences will come to light as progress is made in reconstructing the city of San Francisco. As has been mentioned in these columns, the warehouse of the San Francisco office of the General Electric Company was completely destroyed by the earthquake and fire, the apparatus burned including a stock of the company's heating devices. Recently in cleaning up the ruins, the workmen found a flat-iron, with its wooden parts burned away. On testing it was found that the electrical element was still as good as new. This iron has been advertised as indestructible, and the statement will probably never be better proven than in the present instance.

Remote Control Switch.

The Pettingell-Andrews Company, Boston, Mass., has placed on the market a

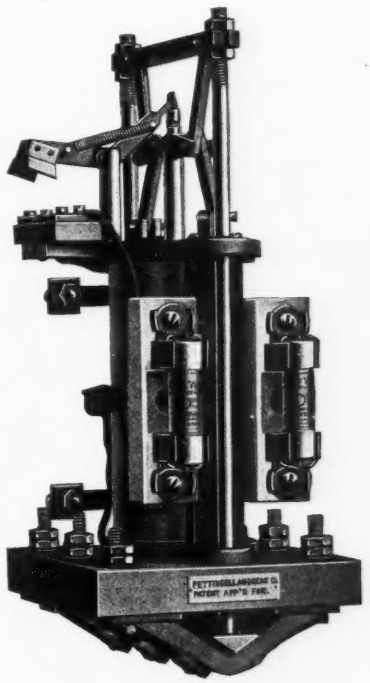


FIG. 1.—REMOTE CONTROL SWITCH, CLOSED.

remote control switch for direct or alternating current. Fig. 1 and Fig. 2 show the "P. A." type D-2 remote control switch.

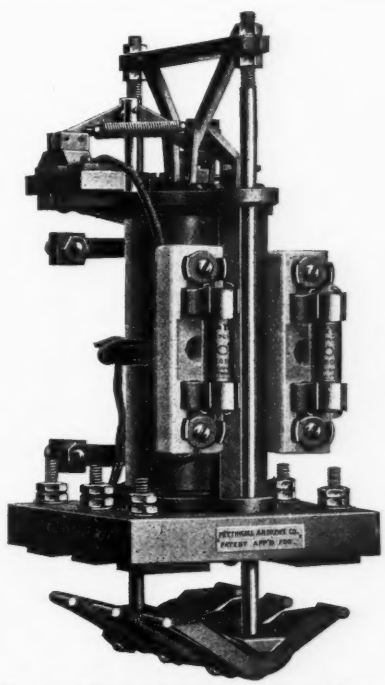


FIG. 2.—REMOTE CONTROL SWITCH, OPEN.

In construction this switch is simple, all parts being self-contained. The main frame is an iron casting which forms,

with the armature, a closed magnetic circuit for each coil. The movable members of the switch consist of laminated brushes equipped with an auxiliary spark break, so that the switch will not fail to operate; nor will it even stick through any roughening of the contact points due to constant use or abuse. It is compact, and the terminals are so located that it permits a neat method of connection in either wire or bus-bar construction.

All parts of switches of the same capacity, including the coils, are interchangeable. The coils are form wound, and the switch may be changed for direct or alternating-current work by substituting the proper coils. The method of operation is simple, the motion being transmitted from the armature to the switch arm through a double lever toggle, which, when the armature has fully completed its closing motion, locks the switch firmly closed and simultaneously breaks the energizing circuit through the closing solenoid. The switch is held closed without the assistance of the current-carrying parts, and if the closing impulse is, for any reason, not sufficiently strong to entirely close the switch, it will instantly open by gravity, rendering the danger of a continuing arc, due to an improperly closed switch, impossible. The opening coil, when energized, trips the lock of the toggle and the switch opens by gravity, at the same time breaking the energizing circuit through the opening solenoid.

Power-Door Mechanism.

Electrical mechanism of a novel and ingenious kind has been developed in the evolution of the system of electrical power doors now installed upon some of the newer cruisers and battleships of the United States navy.

The photograph herewith shows the power box of the latest model of these "Long Arm" power doors, with the protective cover removed in order that the motor, controller and operating gear may be clearly seen.

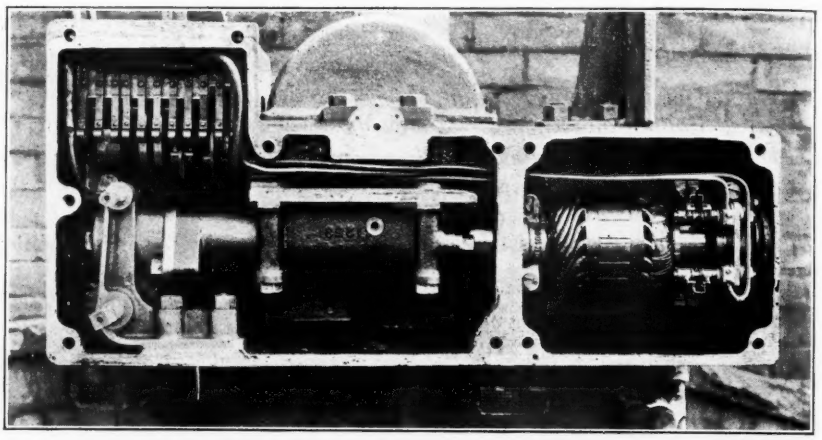
The motor itself is of special construction, designed to stand the abrupt starting and stopping of the power doors in time of emergency. This motor is directly connected to a worm engaging a worm wheel, which, in turn, transmits the load through its shaft and a pinion to a pin rack upon the bulkhead door plate. In performing its work the worm exerts a thrust in the direction of its axis and this thrust is borne by a specially constructed bearing supported by a heavy helical spring. This spring has upon it an initial load equal to the greatest thrust which it is desired that the motor should deliver. As soon as the thrust actually exerted by the worm exceeds the initial compression upon the spring it gives way slightly, allowing the worm shaft to move axially. This motion of the worm shaft is multiplied and used to cut off the current, and the same motion in the reverse direction, when the load is removed, will complete the circuit which it has previously broken.

In this way the automatic cutout protects the motor by opening the circuit as soon as the load upon the motor becomes too great for it to safely handle, and when the load decreases to a safe amount the circuit is automatically closed by the same device. The usual means of protecting motors by fuses on incoming circuits would not be suitable for a power door for the reason that if the door plate should strike an insuperable obstruction in closing, and the fuse should be blown, the door would be absolutely inoperative until some one could replace the fuse.

An important feature of the power mechanism is the "liberty action," which gives men in the vicinity of the doors a means of interrupting their closure from the central station above deck. By operating a handle placed on each side of the bulkhead, the door may be opened while the emergency is "on." After the handle is released the door again closes without further manipulation. In other words, the "liberty action" provides a means of escape or passage from one compartment to another, and makes it impossible at the same time for any door to be left open in the excitement of a disaster.

All the bulkhead doors equipped with this power mechanism are connected with the central emergency station on the bridge of the vessel. A turn of a hand wheel throws the station into action, and by a step-by-step switching mechanism the doors are automatically started at three-second intervals, thus avoiding a sudden and large demand on the ship's dynamos.

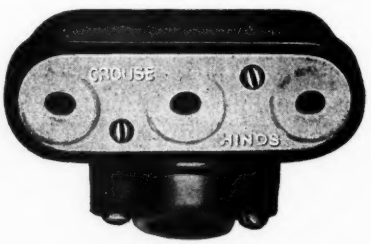
This door is built by the Long Arm System Company, Cleveland, Ohio.



POWER BOX OF THE "LONG-ARM" ELECTRICALLY OPERATED BULKHEAD DOOR, WITH PROTECTIVE COVER REMOVED. SHOWING MOTOR, CONTROLLER AND OPERATING GEAR.

The Crouse-Hinds Company's Condulets.

The Crouse-Hinds Company, Syracuse, N. Y., has recently placed on the market a line of condulets which is meeting with very great approval for all styles of wiring. The type "F" service entrance condulet, shown in the accompanying illustration, is one that appeals to the central station man and is being used very extensively. The central station man for a long time has been in search of a desirable service entrance box or fitting which can be



CROUSE-HINDS "CONDULETS."

used in either a horizontal or vertical position, securing weatherproof protection in both cases. The fitting which is illustrated herewith meets these various requirements and is so designed that the wires are not twisted in the installation of the fitting. The condulet is made for all sizes of rigid conduit up to and including three inches.

These condulets are made in various forms to meet every character of wiring work.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW YORK CAPITALISTS FORMING CHICAGO TRACTION COMPANY—A new traction company, to take the place of the Chicago Union Traction and the underlying companies, is said to be in process of formation in New York city, pending the settlement of the controversies between the Union Traction and the North and West Traction Companies.

ELECTRIC LINE FROM DETROIT TO ADRIAN, MICH.—A line eighty miles long between Detroit and Adrian, Mich., will be built by the Detroit, Ypsilanti, Ann Arbor & Adrian Shore Line. The company has secured all necessary franchises and what practically amounts to a private right of way. The route selected will touch on the main line Delray, Woodmere, Romulus, French Landing, Belleville, Willis, Whittaker, Milan and Macon.

TRI-CITY RAILWAY AND LIGHT COMPANY—C. J. McCraig, Montreal, Canada, and F. W. Ballie, of Toronto, Canada, are at the head of the Canadian syndicate that has purchased $1,300,000 of the preferred stock of the Tri-City Railway and Light Company, which owns the tramway and lighting companies of Davenport, Iowa, and Rock Island and Moline, Ill. Mr. McCraig has placed a number of leading American traction stocks on the leading exchanges of Canada.

OREGON ELECTRIC RAILWAY INCORPORATED—The Oregon Electric Railway Company has been incorporated with a capital stock of $2,000,000 to build an electric road from Portland to Roseburg, through Salem and other towns in the Willamette valley. The incorporators are T. Scott Brooke, H. L. Corbett and R. W. Lewis. The assumption is that the Oregon Electric Railway Company was formed to take over the property and right of way of the Willamette Valley Traction Company.

BELL TELEPHONE OF CANADA—Some time ago the Bell Telephone Company of Canada asked the Dominion government to grant it leave to increase its capital from $10,000,000 to $50,000,000, claiming that within the next few years it would take that amount to keep pace with the growing country and the demands upon the company. The parliament of Canada, however, received numerous petitions, asking that the increased capitalization be not allowed, and finally it has been agreed that the corporation be permitted to increase its capital to $30,000,000.

CHICAGO ELEVATED BONDS SOLD—The Illinois Trust and Savings Bank, Chicago, Ill., reported on May 24 that of the $1,500,000 South Side Elevated bonds delivered to it on May 1, nearly all had been sold. The sales have been made largely to small purchasers, who have taken from $1,000 to $5,000 worth. The syndicate which has underwritten the entire issue of $8,000,000 of South Side improvement bonds still has $1,000,000 worth to deliver to the Illinois Trust and Savings Bank May 1 next year. The bonds draw four and one-half per cent interest, and are a first lien on the company's earnings.

TO INSTALL POWER PLANT AT LOS ANGELES, CAL.—The Pacific Light and Power Company, Los Angeles, Cal., has contracted with Charles C. Moore & Company, San Francisco, for a complete power plant to be installed at Redondo, a suburb of Los Angeles, for supplying power to the street railway system of that city and surrounding towns. This plant will be connected with the various other power plants and the water transmission system in the vicinity of Los Angeles, to ensure continuous service. The nominal capacity of the new generating station will be 15,000 kilowatts, consisting of three 5,000-kilowatt units.

MANUFACTURERS' TELEPHONE COMPANY—The organization of the Manufacturers' Telephone Company, backed by the Illinois Manufacturers' Association, is in the hands of a committee consisting of L. W. Noyes, John E. Wilder, C. H. Smith, Gustav Hessert, Jr., and John M. Glenn. The company has been incorporated at Springfield, Ill. In return for a franchise to build, own and operate a general telephone system, it will quote rates averaging one-third of the present schedules of the Chicago Telephone Company, give the city representation in its management, and secure the consent of the city in fixing prices or raising its capitalization.

ELECTRIC MERGER IN PENNSYLVANIA—It is announced that the consolidation of the Newcastle, Youngstown, Warren and Niles street car lines and the connecting interurban lines has been completed under the name of the Shenango & Mahoning Valleys Light and Power Company. The capital stock is $10,000,000. The individuality of the subsidiary companies will be retained for operating purposes. The merged company will complete trolley communication from Cleveland, Ohio, to the Mahoning and Shenango valleys by building a link at Garrettsville. This will give through trolley service from Cleveland, Ohio, to Pittsburg, Pa., when the Newcastle & Harmony line is extended to Pittsburg, as is now planned.

THE CHATTANOOGA ELECTRIC COMPANY TO ENLARGE ITS PLANT—The Chattanooga (Tenn.) Electric Company will spend immediately between $75,000 and $100,000 adding machinery to its power plant. The Chattanooga plant is one of the largest power plants in the South. All the machinery now being used is of the latest pattern, designed according to the most approved lines. One reason for the success of the corporation is the very progressive work of Mr. Byron T. Burt, the manager of the company. Mr. Burt has initiated a number of practical ideas with reference to improving the service, and has been a very material factor in the development of the demand for current in the territory that the company is serving.

FEDERAL COURT DENIES APPLICATION FOR RECEIVER FOR THE PIKE'S PEAK HYDROELECTRIC COMPANY—A telegram has been received from G. A. Taff, president of the Pike's Peak Hydroelectric Company, Colorado Springs, Colo., stating that the application for a receiver for the company has been denied by the Federal Court. Mr. Taff further states that, while it is true that a receiver has been asked for in connection with the affairs of the company, it is not true that the company is in any way insolvent. For the benefit of the minority holders of bonds, he wishes to state that the affairs of the company were never in better condition, its earnings during the past year being about $20,000 over and above operating expenses and interest charges. The default in the payment of interest was brought about by the withholding of payments by a large consumer, amounting to some $15,000.

CHICAGO EDISON—The lighting committee of the Chicago (Ill.) council has recommended for passage, with certain amendments, the ordinance reducing the rates charged by the Chicago Edison and Commonwealth Electric companies. The rates fixed are fifteen cents per long hour the first two years and thirteen cents the next three; and ten cents per short hour the first year, nine cents the second, eight cents the third, seven cents the fourth and fifth. A discount of one per cent per kilowatt-hour is to be deducted from bills paid within ten days. The companies are authorized to consolidate, but, when consolidated, three per cent of the gross receipts of both are to be paid to the city as compensation. To expedite the sale of its bonds, the franchise of the Commonwealth company is amended so as to run to its successors or assigns. One amendment provides that the rates shall never exceed the schedule fixed in the ordinance, and another prohibits consolidation with a foreign corporation.

CINCINNATI GAS AND ELECTRIC DEAL—Negotiations for the lease of the Cincinnati Gas and Electric Company, Cincinnati, Ohio, by New York banking interests have been completed. A. S. White, 38 Wall street, New York city, has been the chief negotiator in the transaction. The lease of the Cincinnati company will be turned over to the Union Gas and Electric Company, a projected corporation, the incorporation papers of which have been filed under the laws of Ohio. It will have a capital stock of $20,000,000, of which $10,000,000 is six per cent preferred and $10,000,000 common.

The Union Gas and Electric Company will also be a financing company, and will take up and develop enterprises similar to the Cincinnati Gas and Electric Company. It is understood that the Union Gas and Electric Company will guarantee four and one-half per cent on the stock of the Cincinnati company for the first two years, four and three-quarters per cent for the second two years, and five per cent annually thereafter.

NORTHERN COLORADO POWER COMPANY COMPLETES DEAL—The Northern Colorado Power Company, by the payment of $400,000 in cash on May 14, completed the deal for the consolidation of the electric power plants of the northern district of Colorado. The deal for the purchase of the two plants of the Consumers' Electric Company at Lafayette and Louisville was also completed. The plant at Boulder was purchased a week before, making $750,000 that has been paid out altogether. A meeting of the directors of the Northern Colorado Power Company was held on May 14, and contracts were let for machinery for a power plant at Lafayette. An issue of bonds was also ordered. The company has been reorganized with a capital stock of $3,000,000. The contracts for power and transmission lines were let to Westinghouse, Church, Kerr & Company, and to the Westinghouse Machine Company for the turbines. The company is preparing plans and specifications for a large central power plant, to be erected at Lafayette, with 167 miles of transmission lines, which will traverse the northern part of Colorado and the southern part of Wyoming. The total amount to be invested will be close to $2,000,000.

PORTCHESTER COMPANY SECURES A FRANCHISE—The long fight of the New York & Portchester Railroad Company to obtain the right to cross certain streets and avenues in the borough of the Bronx, New York city, and to construct and operate an electric railway from the Willis avenue bridge to the city line, has resulted in a victory for the company by the granting of a franchise by the Board of Estimate and Apportionment on May 18. The company acquired franchises to run its railroad through eight towns in Westchester county three years ago. It is to be an eight-track road, having a length of twenty-five miles, with a terminal in Portchester. The route is to be entirely on property owned by the company. The first application for a franchise was made in March, 1903. For more than two years the franchise was held up, and in the meantime the application of the New York, Westchester & Boston Railway Company for a franchise on a similar route was passed. When the legislature transferred to the Board of Estimate and Apportionment the power to grant such franchises, and the Court of Appeals decided that the law was constitutional, it became possible for the Portchester company to make headway with its application. By the terms of the franchise granted, the company is to pay the city $8,000 a year for the first five years, $13,000 a year for the next five years, and $35,000 a year for the next fifteen years, at the end of which time the company can get a renewal of the franchise for another twenty-five years on a revaluation. In addition, the company must pay 5.4 cents a linear foot a year for its trackage in the Bronx for the first five years, 7.7 cents for the next five years, and twenty-nine cents a foot for the rest of the time the franchise runs. It is provided, also, that the company must deposit $100,000 with the comptroller as a guarantee that it will spend at least $1,000,000 in work on the railroad within five years. The company binds itself also not to sell or mortgage its property to another railway. It is bound to run not less than sixty trains daily in each direction after the road is in operation, and to give a five-cent fare within the city limits.

LEGAL NOTE.

ARMATURE VENTILATING SYSTEM DECISION—A decision has been handed down by Judge Seaman in the United States Circuit Court of Milwaukee, Wis., in a suit, the effects of which are of great importance to the electrical industry. This case involved a suit of the General Electric Company against the National Electric Company, in which the former alleged that a patent controlling certain features of construction in an electric generator was infringed. This feature refers to a form of ventilating the armature, preventing overheating of the machine. The decision of Judge Seaman is a concurrence of a similar opinion by Judge Thompson, of the Ohio District Court, and restrains the National Electric Company from the further manufacture of this ventilating feature.

ELECTRIC LIGHTING.

BARRE, VT.—The People's Light, Heat and Power plant has been sold to Boston and Springfield capitalists. The plant cost $130,000.

GAINESVILLE, GA.—Work is progressing near Oakwood, on the electric power line, which will convey current from the Dunlap dam at Chattahoochee park.

CANON CITY, COLO.—The Canon City council has entered into a new five-year contract with the Colorado Light and Power Company for street lighting.

SYRACUSE, N. Y.—C. A. Lux, of Syracuse, is interested in a project to generate electric power from the Salmon river falls in the town of Redfield, near Oswego.

EATON, IND.—It is reported that a deal, whereby the property of the Eaton Electric Light Company becomes an asset of the Dayton & Western Traction Company, has been consummated.

WENATCHEE, WASH.—Plans are on foot for the establishment of an electric plant at Chelan falls which will furnish power for the irrigation of a large tract of land on the opposite side of the river.

ST. LOUIS, MO.—The village council of Grafton has granted a franchise for an electric light plant in that village to L. T. Westrich. A company has been organized with a capital of $10,000 to build the plant.

GRAND RAPIDS, MICH.—The M. B. Wheeler Electric Company has given up the project of harnessing White river. The company is now planning to develop the Manistee river. Power will be transmitted through Western Michigan.

ASHEVILLE, N. C.—The Asheville board of aldermen has signed a five-year contract with the Asheville Electric Company for lighting the streets of the city. The contract specifies that for the present 150 arc lights the city shall pay $65 per annum.

LINTON, IND.—It is announced that John McFadden, of Chicago, has given up his option on the Linton electric light plant and that the power-house and system will revert to the city. McFadden bid $32,000 for the property and his offer had been accepted.

WILKESBARRE. PA.—The Nanticoke Dam Power Company has filed a mortgage for $500,000, to the Girard Trust Company, Philadelphia, Pa. The mortgage covers all the recent purchases of the company, including the dam and land along the Susquehanna.

GRAND RAPIDS, MICH.—The expense per arc lamp for lighting the streets of Grand Rapids was $35.14 during the last municipal year. This is a reduction of $5.22 from the cost of operation and maintenance during the year 1904-05, when the figure was $40.36 per lamp. In each case the figures include everything except interest and depreciation.

TELLURIDE, COLO.—The Telluride Power Company has broken ground for the erection of a new station adjoining the present one at Ames. The plant will have a generating capacity of 5,000 horsepower, double that of the old one, which it will replace when completed. The company is making arrangements for extending its lines to Silverton. They already extend as far as Red Mountain.

GRAND FORKS, BRITISH COLUMBIA—The British Columbia Construction and Distributing Company, Limited, is the new name under which the West Kootenay Power and Light Company, of Grand Forks, British Columbia, will be known in the future. The company will continue the construction of its line as far west as Boundary fields, the western extreme of its fifty-mile limit, according to its present charter. An extension of the charter will be asked of the next provincial legislature.

LANDER, WYO.—The Wyoming Power and Light Company, organized to supply Lander and the surrounding settlements with electricity, has been financed, and arrangements now are in progress for the installation of the company's plant, which will be operated by water-power. The company intends to supply electricity to South Pass, Atlantic, Fort Washakie, Arapahoe agency and a number of other points. It will supply power also for the operation of the electric railway which is to be constructed after the opening of the Wind river reservation.

PERSONAL MENTION.

MR. BENJAMIN J. WEEKS, until recently general manager of the Spokane (Wash.) Traction Company, has been appointed general manager of the Pacific Traction Company, with headquarters at Tacoma. He is succeeded in Spokane by Clyde M. Graves as general manager.

MR. WALTER ROBBINS, assistant to the manager of the apparatus department of the Western Electric Company, of Chicago, has resigned his position with that company, and will enter the service of the Wagner Electric Manufacturing Company, St. Louis, as assistant to the manager of that company. This change will become operative July 1.

MR. S. YOSHISAKA, a graduate of Purdue University, is about to establish an agency for electrical goods at 47 Second street, San Nomiyee, Kobe, Japan. Mr. Yoshisaka has had a great deal of varied experience in the electrical field, and desires to get in touch with American manufacturers of electrical apparatus as a local representative.

MR. E. C. BRADLEY, vice-president of the Postal Telegraph Cable Company, returned to New York from San Francisco Monday of this week. Mr. Bradley states the damage done by the earthquake and fire had not been exaggerated, but the pluck and courage of the citizens were in evidence on all sides. San Francisco, he says, will be rebuilt on beautiful and at the same time thoroughly practical lines. A comprehensive system of new offices for his company is being installed.

MR. H. M. LAURITZEN, illuminating engineer with the Holophane Glass Company, New York, N. Y., will leave New York about June 9 for an extended western trip, which will be devoted to special illuminating engineering work. Mr. Lauritzen will spend a week in Chicago and then go directly to the coast, spending a week each at Los Angeles and San Francisco, then to Portland, Ore., spending six weeks with the Portland General Electric Company. Two weeks will be spent at Seattle, Wash. Mr. Lauritzen, who is a member of the Illuminating Engineering Society, expects to be in New York about the middle of September.

MR. CABOT STEVENS, for many years electrical engineer of the Edison Electric Illuminating Company, of Brooklyn, N. Y., on June 1 severed his connection with that company, having accepted a responsible position with Messrs. Stone & Webster, of Boston, Mass. Mr. Stevens's associates in the Brooklyn company heard of his decision with regret, and on Tuesday, May 29, tendered him a farewell dinner at the Brooklyn Club. General Manager W. W. Freeman and General Superintendent Walter F. Wells and others expressed their appreciation of Mr. Stevens's character and services, and voiced the general regret at his departure. Mr. Joseph Becker, Jr., superintendent of the meter department, on behalf of the staff council of the company, and as some slight token of their esteem, presented Mr. Stevens with a diamond pin and link cuff-buttons. Mr. Stevens's first work in his new field will be at Columbus, Ga., where he will represent Messrs. Stone & Webster in the construction and operation of a large light, power and railway plant.

NEW MANUFACTURING COMPANIES.

NEW BRUNSWICK, N. J.—The Standard Electric Accumulator Company, of New Jersey, has filed articles of incorporation with the county clerk. The capital stock is $1,500,000. The incorporators are: Edward Barcalow, Frank R. Jones and Edward Morris.

JOHNSTOWN, PA.—Charter has been issued to the Zobel & Makin Electric Manufacturing Company. The capital stock is $10,000 and the directors are: John Zobel, Carl A. A. Zobel and A. O. Makin. The purpose of the company is to manufacture a new form of electric lamp.

MUSCATINE, IOWA—The Jackson Electric Supply Company has filed articles of incorporation with the county recorder. The capital stock is placed at $10,000, and the officers are: George B. Jackson, president; E. E. Jackson, vice-president; Bruce P. Jackson, secretary and treasurer.

ELECTRICAL SECURITIES.

While irregular and professional dealings were the chief characteristics of recent stock markets, there has been a fairly steady improvement in speculative confidence. There is to be noted a slight improvement in the outside public business, especially as regards investment purchases in the bond market. Only one day last week resulted in very large business, and the first day of the week was noteworthy as one of the dullest of all business days so far this year. It is quite likely that this condition of apathy will prevail for some time. The generally admitted prosperity, the high average of security prices and the general stability of the market have discounted any very great rally which might be hoped for.

ELECTRICAL SECURITIES FOR WEEK ENDING MAY 26.

New York:	*Closing.*
Allis-Chalmers common	21¼
Allis-Chalmers preferred	56¾
Brooklyn Rapid Transit	81¼
Consolidated Gas	136½
General Electric	167⅞
Interborough Rapid Transit	227
Kings County Electric	165
Mackay Companies (Postal Telegraph and Cables) common	72½
Mackay Companies (Postal Telegraph and Cables) preferred	73¼
Manhattan Elevated	152
Metropolitan Street Railway	113
New York & New Jersey Telephone	140
Western Union	92⅝
Westinghouse Manufacturing Company	156

Boston:	*Closing.*
American Telephone and Telegraph	137¼
Edison Electric Illuminating	245
Massachusetts Electric	68
New England Telephone	137
Western Telephone and Telegraph preferred	90

The annual report of the Edison company for the year, to end June 30 next, will show an increase in gross and net earnings of about 10 per cent, with a substantial increase in surplus. For the year ended June 30, 1905, the company showed gross earnings of $3,346,027, net of $1,236,206, and surplus after interests and dividends of $71,415. There has been a large increase in the business of the company the past fiscal year, particularly in incandescent lamps, which to date represent 19 per cent increase over a year ago, while the arc lamps connected show a 10 per cent increase, and motors, in horse-power equivalent, about 17 per cent increase.

Philadelphia:	*Closing.*
Electric Company of America	11¼
Electric Storage Battery common	72½
Electric Storage Battery preferred	72½
Philadelphia Electric	7¾
Philadelphia Rapid Transit	25½
United Gas Improvement	85¾

The full pamphlet report of the Philadelphia Electric Company for the year ended December 31 last has been issued, and the general balance sheet shows a loss in cash and a gain in the profit and loss surplus, the former of $728,489 and the latter of $311,082. The capital stock of the company now is $24,987,750, having been raised from $7,500,525, and there also are guaranteed gold certificates to the amount of $15,014,142. Among other liabilities are $1,994,300 of Edison Electric guaranteed 5 per cent trust certificates and $11,268,060 Philadelphia Electric 5 per cent guaranteed trust certificates. On the other hand, there are $13,263,360 of unused stocks of sub-companies deposited and used as a basis of the Philadelphia Electric trust certificates, spoken of above. The company holds $19,359,220 in stocks of miscellaneous companies, and has advanced $5,066,464 to its subsidiary corporations.

Chicago:	*Closing.*
Chicago Telephone	121
Chicago Edison Light	149
Metropolitan Elevated preferred	68
National Carbon common	90
National Carbon preferred	120
Union Traction common	4
Union Traction preferred	12

The annual meeting of the Chicago Edison Company will be held at noon, June 11.

TELEPHONE AND TELEGRAPH.

EUREKA, UTAH—The Bell Telephone Company will erect a new building on Main street.

LAWRENCEVILLE, VA.—The Brunswick Mutual Telephone Company has installed an additional hundred-drop switchboard.

ANDOVER, MASS.—The New England Telephone and Telegraph Company has been authorized to install its system in Ballardvale.

KNOXVILLE, TENN.—Bids have been asked for the work of enlarging the East Tennessee Telephone Company's building in Knoxville.

SPOKANE, WASH.—Citizens of Echo Valley, in Stevens county, are putting in a telephone system that will connect the neighborhood with Colville and Spokane.

MONTGOMERY, ALA.—The Meridian Home Telephone Company, of Mississippi, has been authorized to do business in Alabama, and D. S. Knight has been appointed agent.

SPARTA, TENN.—The Gainesboro Telephone Company will issue bonds to the amount of $100,000 for extensions and improvements. Joel H. Anderson is general manager.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company has obtained permits to build two new telephone lines, one near Mount Carmel and the other near Phœnix.

BELVIDERE, ILL.—The Belvidere Telephone Company has decided to rebuild its lines and put in an entirely new and modern system. The change will cost in the neighborhood of $25,000.

UTICA, N. Y.—Announcement has been made of the purchase by the Bell Telephone Company of the independent Ontario Telephone Company, of Oswego. For each $50 of stock the purchase price was $65.

ALBUQUERQUE, N. M.—The Colorado Telephone Company will at once commence the erection of a building at Raton. The capacity of the plant will be greatly enlarged, requiring an expenditure of about $70,000.

BALTIMORE, MD.—Work has been begun by the Philadelphia, Baltimore & Washington railroad for the connection of the three cities by private telephone. Four new lines will be strung on the company's poles.

HOLLAND, N. Y.—The Bell Telephone Company has bought out the Cazenovia Telephone Company and will give day and night service with East Aurora and other points. The company intends installing an exchange in Holland and will extend the service.

ELY, NEV.—The Bell Telephone Company is to spend a quarter of a million dollars in developing its lines in the eastern part of Nevada. It will build long-distance lines and local systems in White Pine, Lincoln and Eureka counties, and extend its service in Elko county. Local systems will be installed at Ely, Eureka, Caliente and Pioche.

NEWARK, N. J.—The Lebanon Telephone Company is making arrangements to extend its lines in many directions. At a recent meeting the following officers were elected: president, Samuel J. Shurts; vice-president, George Clark; secretary, A. O. Farley; treasurer, Eratus W. Sutton. Directors: Joseph C. Farley, Dr. Henry H. Miller and James E. Ramsey.

COLUMBUS, IND.—An agreement has been reached between the new long-distance company and the local Bell company, by which the Bell will close its exchange at Columbus and stop preparations for establishing an exchange at North Vernon. The Bell toll-boards in each place will be trunked into the independent city boards, and the two companies will operate together.

PIERRE, S. D.—The records of the secretary of state show the filing of more than sixty new telephone companies in South Dakota for the last ten months. Many of these are rural lines connecting the farms in the more thickly settled portions of the state, and many are small private lines. Several such lines have been put in service among ranchmen, especially in the vicinity of Leslie.

WENATCHEE, WASH.—The Farmers' Telephone and Telegraph Company is installing a switchboard with a capacity of 1,000 lines in the Wenatchee office. The company was started a few years ago with an investment of $8,000 and less than fifty subscribers. To-day $30,000 has been invested in the company. The officers hope to extend the line to Leavenworth and to points east in a very short time.

OKLAHOMA, OKLA.—The Gross Construction Company has secured the contract for the construction of a five-story and basement building, to be erected by the Pioneer Telephone Company. The new building will cost, when completed, the sum of about $125,000 and will be modern in every respect. The structure, which will be used as the home and offices of the telephone company, will be built to permit of the addition of two stories.

WASHINGTON, D. C.—Orders have been issued by Gen. Allen, the chief signal officer of the army, for the installation of the duplex system on the Alaskan cables. The commercial business of the cables has become so heavy that the operators are not able to handle all the dispatches. With the new system the capacity of the cables will be increased about seventy-five per cent. Many changes in the telegraph lines in Alaska are also in contemplation by the Signal Corps.

MAYSVILLE, KY.—The Bell Telephone Company, of Cincinnati, has asked the Maysville council for a twenty-year franchise. Vice-President Bayard Kilgour, of the Cincinnati & Suburban Bell Telephone Company, states that the application is being made by the Citizens' Telephone Company, of Kentucky, the Kentucky branch of the Bell company. The lines of the company are now within a very few miles of Maysville, and it is desired to establish a branch exchange in that city.

CAMDEN, N. J.—By the purchase of eighty per cent of the stock the Keystone Telephone Company, of Philadelphia, Pa., has acquired control of the Eastern Telephone Company, of Camden, and the Eastern will hereafter be operated from the Keystone office, Philadelphia. A traffic agreement has been in force between the two companies for some time, and the change in ownership will cause no interruption in the service, although the Keystone company will within a few months very much improve the service of the local corporation. The Eastern Telephone Company was organized in 1899, and began operations in 1901, and at the present time has about 2,500 subscribers. The capital stock of the company is $250,000. The Keystone company assumes the indebtedness of the Eastern company, which is about $75,000. There is also a bond issue of $250,000, and the Keystone company has the option of taking the bonds at par. The Eastern Telephone Company operates in Camden, Gloucester and a portion of Burlington county. Its stock has never been sold in the open market.

CINCINNATI, OHIO—The board of directors of the Cincinnati & Suburban Bell Telephone Company has voted to make a sweeping reduction in residence telephone rates. The present yearly rates for telephones in residences, for unlimited services, are: single line, $60; two-party line, $48; four-party line, $30. Under the new schedule there will be no four-party line. The service and yearly rates will be as follows: single line, $48; two-party line, $30. Extension sets will be reduced from $12 to $9, and double sets, from $17 to $12. Bayard L. Kilgour, vice-president and general manager of the telephone company, said that the changing of the four-party line service to a two-party line will mean an expenditure of $75,000, and an increase in the operating employés of about ten per cent. He hopes to be able to have all the changes made so as to be in operation by the first of next July. Additional switchboards must be placed in every one of the exchanges, in order to conform with the changes. The telephone numbers will also have to be changed to a large extent in the residential districts. The same territory will be in the free, unlimited zone as at present, comprising all of Hamilton, Kenton and Campbell counties, and also part of Boone and Clermont counties, making a free area in telephoning of 340 square miles.

EDUCATIONAL.

GRADUATION EXERCISES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The graduation exercises of the class of 1906 of the Massachusetts Institute of Technology will be held in Huntington Hall, Rogers Building, 491 Boylston street, Boston, Mass., on Tuesday, June 5, at 2.30 P. M. The several buildings of the institute, with libraries, laboratories, drawing rooms, etc., will be open to visitors immediately after the exercises.

NEW INCORPORATIONS.

LANSING, MICH.—Osceola Telephone Company, Hartwick. $10,000.

FRANKFORT, KY.—Schocholi Telephone Company, of Logan county. $2,500.

FRANKFORT, KY.—Monticello Electric Light and Power Company, Wayne. $6,000.

CLINTON, IOWA—Iowa & Illinois Railway Company. Capital increased from $1,800,000 to $2,300,000.

LINCOLN, NEB.—The Medicine Valley Telephone Company, of Hayes county. $1,500. Incorporators: R. P. Chase and J. C. Ready.

LITTLE ROCK, ARK.—City power, light and water company, of Augusta. $50,000. Incorporators: J. R. Vinson and A. H. Campbell.

HENRYETTA, I. T.—The Coal Creek Power Company. $10,000. Incorporators: J. W. Stewart, W. N. Martin and William Stockleberg.

ALBANY, N. Y.—The Triangle Telephone Company. $1,000. Incorporators. C. B. Self, DeW. Beardsley, C. E. Adams, Triangle, N. Y.

ST. PAUL, MINN.—Westside Telephone Company, Hitchcock. $5,000. Incorporators: B. W. Lanphier, W. P. Price, Frank Gilley, Hitchcock.

AUGUSTA, ME.—The West Lovell Telephone Company. $1,000. Officers: President, W. S. Fox, of Lovell; treasurer, George W. Andrews, of Lovell.

PIERRE, S. D.—Farmers' Union Telephone Company, of Colman, Moody county. $9,000. Incorporators: A. S. Harvey, Andrew Ulstad and Ole Mickkelson.

AUSTIN, TEX.—Mount Zion & Lost Creek Telephone Company, of Gordon, Palo Pinto. $1,000. Incorporators: W. H. Rix, R. M. Vaughn and W. J. Pierce.

ALBANY, N. Y.—Southwest Oswego Telephone Company. $600. Incorporators: Frank McBride, Frank J. Eaton and Percy Flack, all of Oswego, N. Y., and others.

ALBANY, N. Y.—Montour Falls Telephone Company. $10,000. Incorporators: George F. Barton, Frank Johnson and D. C. Blair, all of Montour Falls, and others.

COLUMBIA, S. C.—Catawba Valley railway. To complete the railway started between Catawba Junction and Catawba Falls, a distance of twenty miles. $45,000.

LINCOLN, NEB.—Farmers' Mutual Telephone Company. $10,000. Incorporators: William F. Torbitt, Evens M. Meyers, John T. Dobbs, Harry Honor and Everitt W. Randall.

COLUMBUS, OHIO—The Minerva Telephone Company, of Stark county. $4,000. Incorporators: E. D. Shaw, R. T. Davis, A. A. Bates, B. C. McCauley and W. E. Russell.

GUTHRIE, OKLA.—The Modern Telephone Company, of Sayre. $10,000. Incorporators. T. S. Wilson, of Prentiss; D. E. Crubbs, O. J. Ivester, L. P. Jones and Robert Rice, of Sayre.

GUTHRIE, OKLA.—The Heaston & El Reno Telephone Company. $5,000. Directors: Charles Brandley, W. J. Murray, J. W. Cordray, S. C. Porter and W. F. Foster, of El Reno, and W. D. McRay, of Heaston.

STEUBENVILLE, OHIO—The Republic Telephone Company. To operate a line at Toronto, Empire and New Cumberland. $25,000. Incorporators: J. G. Gilchrist, R. Gilson, W. C. Jones, Lee O. Smith and J. T. Campbell.

INDIANAPOLIS, IND.—The Cyclone Co-Operative Telephone Company, Cyclone, Clinton county. $500. Incorporators: Albert Strong, William E. Bolt, William G. Irons and Will S. Emley, of Cyclone, and James McIntyre, of Frankfort.

MOUNT STERLING, KY.—The Paris & Mount Sterling Electric Railway Company. $100,000. Incorporators: Henry A. Power, Robert C. Talbott, R. J. Neely, of Paris; W. A. Thomson and John T. Collins, of Middletown; J. M. Bigstaff and H. Clay McKee, of Mount Sterling.

TRAVERSE, MICH.—Electric Land and Development Company. $50,000. To acquire, purchase, hold and sell real estate and to purchase and hold power propositions. Officers: President, Dan J. Albertson; vice-president, William Thirlby; secretary, William H. Umlor; treasurer, A. W. Bartak.

AUSTIN, TEX.—Union Central Light and Ice Company, Hubbard City. To generate and sell electrical current for commercial uses. $25,000. Incorporators and officers: W. August Bass, president and manager; James E. Waller, first vice-president; John M. Carrol, second vice-president.

OLYMPIA, WASH.—The Big Red Apple Railway Company. To construct railways in and between Wenatchee, Monitor, Cashmere and Leavenworth. $10,000. Incorporators: M. O. Tibbetts, Leonard Fowler, A. S. Burbank, C. A. Huston, W. H. Gridley, J. B. Adams, F. M. Scheble and Thomas Bollman.

SANTA FE, N. M.—The Kenton Telephone Company, with headquarters at Clayton, Union county. To build telephone lines in Union county, New Mexico, Baca county, Colorado, and Beaver county, Oklahoma. $2,500. Incorporators and directors: Henry Bearly, J. J. Ballard, John W. Turner, A. W. Henner, R. F. Drew and D. K. Lord, all of Kenton, Okla.

COLUMBUS, OHIO—The Cleveland, Van Wert & Indiana Traction Company, of Van Wert. To build an electric line from Norwalk to Tiffin, Findlay, Ottawa, Kalida, Ottoville, Van Wert and other municipalities to the state line. $10,000. Incorporators: I. R. Tudor, L. R. Bonewitz, J. J. Humphreys, L. E. Gleason and F. T. Webster.

ALBANY, N. Y.—Centerville Lighting Company. To manufacture and sell electricity for heat, light and power purposes in Ulster and Sullivan counties, especially in the towns of Fallsburgh and Wawarsing, and in the villages of Mountaindale, Centerville Station, Glenwild, Hurleyville and Woodburne. $100,000. Directors: Nathan Lubow, George W. Lubow and Isidore D. Wolf, of Centerville.

NEW PUBLICATIONS.

THE PANAMA CANAL—This pamphlet contains the supplemental statement of Mr. John F. Wallace, submitted to the United States Senate Committee on Interoceanic Canals, Tuesday, May 22, 1906.

COLUMBIA UNIVERSITY BULLETIN OF INFORMATION—The announcement for 1906-1907 of the division of engineering, Columbia University, New York city, is ready for distribution. This bulletin contains full details of the requirements and courses of study in civil, electrical and mechanical engineering and engineering draughting.

COPPER FACTS—An interesting booklet relating to the copper industry, the metal copper and corporation statistics has been compiled by M. J. O'Shaughnessy, Jr., New York city. This booklet contains a great deal of very interesting information, and, in addition to the text, there is a directory of the copper mining and producing companies of the United States.

LITERATURE ON THE SINGLE-PHASE MOTOR—Two valuable papers, entitled, respectively, "A Contribution to the Theory of the Single-Phase Induction Motor," and "A New Single-Phase Commutator Motor," have been reprinted by the author, V. A. Fynn. The first-named paper is reprinted from the *Electrical Review* (London), and the second is an excerpt from the journal of the proceedings of the Institution of Electrical Engineers, of Great Britain.

MANUAL FOR ENGINEERS—A manual for engineers, containing tables and other data, has been compiled by Charles E. Ferris, B. S., professor of mechanical engineering at the University of Tennessee, and published by the University Press, Knoxville, Tenn. This is the sixth edition of the manual. It has been found of very great value to thousands, and the fact that each succeeding year the edition has been very greatly increased indicates its popularity. The book is of vest-pocket size, well printed, the leaves being finished with gilt edges and bound in a flexible black Russia leather cover.

ELECTRIC RAILWAYS.

AKRON, OHIO—Contracts have been let for the construction of double tracks on the Akron, Bedford & Cleveland electric line.

NASHVILLE, TENN.—The secretary of state has granted the Knoxville Railway and Light Company an amendment to its charter, so as to enable it to extend its system.

LOS ANGELES, CAL.—Henry E. Huntington has given orders to begin work immediately on four-tracking the Long Beach line of the Pacific electric system for a distance of eight miles.

DES MOINES, IOWA—The contract for the electrical equipment of the Fort Dodge, Des Moines & Southern Electric Railway has been awarded to J. G. White & Company, of New York.

OLIN, IOWA—Right-of-way is now being acquired for an interurban line from Dyersville south to Davenport. The road, as projected, will pass through Hopkinton, Olin, Stanwood, Monticello and Tipton.

PORTLAND, ORE.—The Pence company has been granted a franchise to construct and operate a standard-gauge, double-track electric line on the county road from the west end of Nicolai street to Linnton.

SUFFOLK, VA.—The Norfolk-Portsmouth Traction Company, a merger of the street car and power plant concerns in Eastern Virginia, has borrowed $8,000,000 from the Trust Company of North America.

CHEHALIS, WASH.—The Centralia-Chehalis Electric Railway and power company has been voted a thirty-five-year franchise to operate in Chehalis. The Centralia-Chehalis Company was organized last fall to build an interurban line between the two cities.

SALT LAKE CITY, UTAH—The board of directors of the Lewiston & Southeastern Electric Railroad has authorized President G. W. Thompson to let contracts for the grading of the first eight miles out of Nez Perce. Nez Perce will be on an eighteen-mile branch from Westlake.

WASHINGTON, D. C.—Plans for the construction of a new powerhouse for the Capital Traction Company have been completed. The building, which is to be of brick and two stories in height, will cost approximately $180,000, and will be one of the largest structures of the kind in the city.

KENOSHA, WIS.—It has been stated that the Milwaukee Electric Railway will begin to supply electric power to the farmers of Kenosha and Lake counties very soon. A new company, the Chicago-Milwaukee Power Company, has therefore been incorporated and will operate a $1,000,000 plant near Waukegan.

CHEYENNE, WYO.—Articles of incorporation have been filed for the Wyoming Central Railroad Company, for the construction of a steam or electric road from Arapahoe agency to Fort Washakie and Shoshone agency and from Shoshone agency to Lander, Wyo.; also a line from Arapahoe agency to Shoshone.

PALMER, MASS.—The work of grading for the extension of the Springfield & Eastern electric road through Brimfield to Fiskdale has been begun. There is a large amount of filling and cutting to do, and it is not likely that the road will be in operation this year. Fast time has been planned for, and the grades and curves will be as few as possible.

OSKALOOSA, IOWA—Stockholders of the Oskaloosa & Buxton road have indorsed the proposals of the directors of the road to increase the capital stock to $750,000, acquire a local light, heat and street car plant, and proceed at once to the construction of the interurban to Buxton. Cars must be running by December 1, 1906. Contracts have already been let for grading as far as Beacon.

BROOKLYN, N. Y.—The Brooklyn Rapid Transit Company has agreed to the recent demand of the borough authorities that it should repave and repair all the streets on which it has car tracks. The work, extending over 178 thoroughfares, will cost the company $400,000, and will be carried on under the direction of Public Works Commissioner Dunne. The company will also spend $200,000 for new tracks.

PENSACOLA, FLA.—Stone & Webster, of Boston, have purchased all the securities of the Pensacola Electric Terminal Railway Company and the Escambia County Light and Power Company, giving them the entire electric railway and lighting system of Pensacola, Fla. A new company will be formed to operate the system, which includes about twelve miles of electric railroad and seven miles of steam railroad. The latter will be converted into electric lines.

TACOMA, WASH.—The Pacific Traction Company, which a year ago began the construction of an interurban electric railroad from Tacoma to American lake, with the probability that it would be built on to Olympia, has resumed work. Elmer J. Felt, vice-president of the company, says the money necessary to build the line has now been raised and that it will be completed and trains running from Tacoma to the lake by August 1. The company graded last spring and summer from Tacoma almost to South Tacoma.

TACOMA, WASH.—Work has been begun by the Puyallup Valley Electric Company on its electric railroad from Tacoma to Puyallup. This line, when completed, will be nine miles long. The promoters, who are Puyallup, Sumner and Tacoma capitalists, claim the road will cost $160,000. It is the intention of the company to extend the line to Sumner, and also to McMillan, Orting and perhaps the mining towns of Wilkerson, Burnett, Carbonado and Fairfax, in the eastern part of the county.

TOPEKA, KAN.—Plans are nearly completed for the building of an air line electric railroad between Kansas City and St. Joseph. The scheme involves the building of terminal yards on the Missouri river front at Kansas City, the bridging of the Missouri river at a point west of the Armour-Swift-Burlington holdings in the north end, and the construction of a cross-country line to St. Joseph by way of Excelsior Springs. The mileage of the proposed line between Kansas City and St. Joseph is fifty-two miles.

COLUMBIA, CITY, IND.—Manager A. E. Weist, of the Huntington, Columbia City & Northwestern Railway Company, has made public the statement that work on the construction of the line will begin at Goshen and Syracuse at once. After the line is constructed from Goshen and Syracuse to Huntington, right-of-way will be obtained to extend it south to Indianapolis. Subsidies aggregating $12,500 have been voted the company between Huntington and Goshen, and if the line is not built by March 1, 1907, these subsidies will be forfeited.

SPOKANE, WASH.—Surveyors are in the field for the Farmers' Cooperative Electric Company, which intends to build a railway from Waterville to Ephrata to connect with the Great Northern. J. M. Puckett, president of the company, is authority for the statement that contracts will be awarded soon with a view to completing the line as soon as possible. The company was incorporated in Douglas county with a capital of $100,000, the incorporators being J. M. Puckett, L. E. Leonard, W. F. Naught, O. H. Jahnke and E. E. Higginbottom. It is understood that part of the right of way will be furnished by subscribers to the corporation's stock.

NEW BEDFORD, MASS.—Plans have been perfected for the absorption of the Taunton & Buzzard's Bay Street Railway Company by the New Bedford & Onset Street Railway Company. By the terms of the purchase the New Bedford company is to issue $50,000 of additional stock to the present owners of the Taunton & Buzzard's Bay line as the consideration for the conveyance of all the property and franchises, subject to a bonded debt of $150,000, the interest rate upon which is to be reduced from five to four per cent. The Taunton & Buzzard's Bay line is about thirty miles long and cost, with equipment, about $500,000. It has recently suspended operation.

DANBURY, CT.—Plans are being developed for the construction of an interstate trolley between Danbury and the Hudson river at Ossining, N. Y. It is proposed to employ as the Connecticut end of the line the street railway which the Danbury & Harlem Traction Company is now constructing between Danbury and Goldens Bridge, N. Y. For the Hudson river section of the line it is proposed to use various franchises, which will be consolidated and which in the aggregate carry a large number of valuable rights. Some progress is being made on the Danbury & Harlem line. The rails are now being laid between the New York state boundary and North Salem, N. Y. The grading west of North Salem has not yet been completed.

INDUSTRIAL ITEMS.

THE ELECTRIC CONTRACTING COMPANY, Havana, Cuba, announces its removal to Prado 89, Post Building.

THE LOWE ELECTRIC COMPANY, 54 Vesey street, New York city, will be pleased to send its new bulletin calling attention to special prices on electric fans.

H. M. BYLLESBY & COMPANY, Chicago, Ill., announce the removal of their general offices to the American Trust Building, corner Clark and Monroe streets.

THE SHELTON ELECTRIC COMPANY, Atlas Block, Chicago, Ill., has ready for distribution a new pamphlet describing the Shelton electrical vibratory apparatus.

THE GOULD STORAGE BATTERY COMPANY, New York city, announces temporary offices at 1701 Geary street, San Francisco, Cal. The Crossley Building, in which the company's San Francisco office was located, was destroyed by fire.

MILTON L. HUGHES & COMPANY, 324 Dearborn street, Chicago, Ill., have published a booklet describing "the Hughes' idea." The literature is interesting and the subject worth careful consideration by those who are thinking of effecting economies in the operation of their plants.

JOHN L. GLEASON, Jamaica Plain, Boston, Mass., has published a price list and descriptive bulletin giving full details concerning "Fancleve" electrical specialties. This bulletin calls attention to the Gleason reduction boxes, standard mouldings, moulding boxes and universal boxes for iron conduit.

THE VALENTINE ELECTRIC SIGN COMPANY, Atlantic City, N. J., is prepared to rent complete electric signs to exhibitors during the convention of the National Electric Light Association. These signs consist of twelve-inch electric letters, and include all necessary lamps, wiring and construction work.

THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., in circular No. 775, calls attention to its arc-light specialties, describing and listing its inner globes and arc lamps and arc light regulator. Bulletin No. 605, describing small direct-current motors, is also ready for distribution.

THE FLETCHER MANUFACTURING COMPANY, Dayton, Ohio, will be pleased to send its new folder illustrating and describing a line of "malleable seamless" line material. Prices and descriptions of high and low-tension pins and brackets, wire holders, insulated racks and nested racks will also be sent upon application.

THE WHITE SEWING MACHINE COMPANY, Cleveland, Ohio, has recently published a handsome booklet containing a large number of testimonials from owners of White steam automobiles. In addition to these commendations there are several illustrations of exhibits of the White company at various automobile shows.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., in bulletin No. 1,050 describes alternating-current generators of the water-wheel type. The frontipiece shows an interior view of the hydro-electric plant at Caliente, Cal., where five 3,000-kilowatt Bullock alternating-current generators of the water-wheel type are installed.

THE LEHIGH VALLEY RAILROAD announces a rate of a fare and a third, on the certificate plan, to Chicago for the convention of the National-Interstate Telephone Association, June 25-28. Mr. A. J. Simmons, general eastern passenger agent, 355 Broadway, New York city, will be pleased to send full information concerning this proposition.

W. R. OSTRANDER & COMPANY, 22 Dey street, New York city, have ready for distribution a small catalogue describing and illustrating and giving the list prices of direct and alternating-current fans. In addition to this the company will supply to any one interested, upon request, a trade discount sheet applying to its 1906 fan catalogue.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., in bulletin No. 19 describes and illustrates generator call telephones. This bulletin is handsomely printed in two colors and, in addition to the special telephone literature, gives numerous illustrations of the company's telephone factory.

THE FOSTORIA GLASS SPECIALTY COMPANY, Fostoria, Ohio, will be pleased to send its literature concerning its "Noblac" electrical and gas glassware. A folder which the company has recently distributed gives several pertinent suggestions concerning the inspection of this material. This literature will be sent upon request.

THE LUNDIN ELECTRIC AND MACHINE COMPANY, Boston, Mass., has placed upon the market recently a new line of electrical fittings for central station work. The company will be pleased to send full descriptive matter and illustrations upon application. In electric lighting specialties particularly the company has a very complete line of apparatus.

FAIRBANKS, MORSE & COMPANY, Chicago, Ill., it is announced, have sold a complete cyanide gold mill, the entire plant to be operated by Fairbanks-Morse direct-current dynamos and motors driven by water power. The mill will be located near Boulder, Col., where a 240-foot head of water is available. It is estimated that the mill will have a capacity of 500 tons per day.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., will have headquarters at Rooms 217 and 219, Young's Hotel, directly across the boardwalk from Young's Pier, at the Atlantic City convention of the National Electric Light Association. The company will show a number of instruments of interest to the electric-lighting industry, among them some new models which have never been exhibited before.

THE CANADIAN WESTINGHOUSE COMPANY, Hamilton, Ontario, has recently secured a duplicate order from the Northern Electric and Manufacturing Company, of Montreal, for a 300-kilowatt, Westinghouse-Parsons turbo-generator unit. The generator is a 220-volt, three-phase, 7,200-alternation machine, operating at 3,600 revolutions per minute. It will be of the latest enclosed type and the turbine will operate at 150 pounds pressure with 100 degrees superheat.

THE MOORE ELECTRICAL COMPANY, Newark, N. J., will install a Moore electric lighting tube 186 feet long in the lobby of the theatre on Young's Pier, as one of the prominent features in connection with the National Electric Light convention at Atlantic City. This new form of light is attracting a great deal of attention, and thousands of feet of Moore tubing have been put into commercial use during the last few months in New York, Newark, Pittsburg and Atlantic City.

THE CHASE-SHAWMUT COMPANY, Newburyport, Mass., manufacturer of the well-known "Shawmut" enclosed fuse, is calling particular attention at this time to the ground connection clamp which it is now placing on the market for grounding secondary wires and secondary distributing systems. These clamps are strongly constructed and are made in sizes from one-half inch to three inches. Full information, with prices, may be obtained from the company by asking for bulletin No. 34.

THE STUDEBAKER AUTOMOBILE COMPANY, New York city, has published a very attractive and useful book entitled "Through Italy and France in a Studebaker Car." About half of this book is devoted to giving details of expense, recommendations regarding the hiring of chauffeurs, securing useful maps and guides, and other helpful data concerning customs regulations, hotels, repairs, garages, etc. Copies of this book may be had from any of the branch houses or agents of the Studebaker Automobile Company.

THE EDISON MANUFACTURING COMPANY, Orange, N. J., has published a pamphlet descriptive of Edison's improvement of the Lalande caustic potash shell. It is stated that the energy of the Edison cell, applied through a perfect motor, would raise the cell 16.17 miles. The improvement made by Edison consists in forming

the copper oxide depolarizer into firm briquettes, which reduces both the internal resistance of the cell and the tendency to polarize, at the same time making the renewal of the cell much more convenient.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., general western agent for "Deltabeston" magnet wire, is sending out some literature descriptive of the good qualities of this wire and its adaptability for use on the field and armature coils of railway motors and on arc lamp coils. This product is an asbestos-covered wire, and substantial claims are made that it will withstand the highest temperature without the least injury to the insulation. Prices and samples will be sent on request to the company.

THE WHEEL TRUING BRAKE SHOE COMPANY, Detroit, Mich., is calling attention to the utility of its wheel truing brake shoes with an advertising card displaying an illustration of a man throwing away a number of flat wheels. The announcement is made that the application of wheel truing brake shoes will keep the car in service, and the "flat" will disappear. The saving will more than compensate for the replacing of the ordinary brake shoe. The wheel truing brake shoes are made to fit all styles of brake heads.

THE JANDUS ELECTRIC COMPANY, Cleveland, Ohio, announces a very large demand for its "Gyrofan." This apparatus, as is well known, distributes the air over a very wide area, and consists of two or more Jandus fans mounted upon a shaft, which is rotated by the action of the fan motors. In addition to this the column can be set at the end of an aisle and the blast of air directed in several directions. Quite a number of these "Gyrofans" have been installed recently at Rector's, Chicago, Ill., and also in St. Louis, Mo.

THE HOLOPHANE GLASS COMPANY, New York, N. Y., reports very large sales on its new "Pagoda Reflecting Arc." Owing to the use of ordinary, standard, small unit, incandescent lamps in connection with this arc, dealers and jobbers in all parts of the country are placing them in stock, and selling them for all kinds of places, large and small. The scientific accuracy of reflecting prisms is combined with the artistic, altogether making a most efficient and pleasing-looking fixture. Full particulars and prices can be had by writing to the Holophane Glass Company.

THE WESTINGHOUSE MACHINE COMPANY, East Pittsburg, Pa., has received an order from the Portsmouth Street Railway and Lighting Company to install in its plant at Portsmouth, Ohio, a 500-kilowatt turbine. This is to be of the multiple-expansion parallel-flow type, direct-connected to a 500-kilowatt, sixty-cycle, two-phase, 200-volt Westinghouse generator. The company has two 400-kilowatt Westinghouse-Parsons turbines already operating. Superheated steam and high vacuum are used. Condensing water is obtained from an artificial lake which has been constructed on the property.

THE FRIEDE GLOBE TOWER COMPANY, 27 William street, New York city, is building a remarkable attraction for Coney Island, N. Y. This consists of an immense building which, it is stated, will be 700 feet high, 300 feet across and 900 feet around the base. The capacity of this tower will not be less than 50,000 people at one time. There will be an automobile garage, a pedestal roof-garden, an ærial hippodrome, observatory platform, observation bureau and wireless telegraph station. The electric illumination will be remarkable for its completeness and the extent to which individual light units will be employed.

THE SPRAGUE ELECTRIC COMPANY, 527 West Thirty-fourth street, New York city, is calling attention to its flexible steel-armored hose with an attractive advertising card representing the use of this hose for field work. The steel armor entirely encases the rubber tube, protecting it from external injury. It also acts as a bandage in case the rubber lining becomes damaged from over-vulcanization, and thus prevents the loss of steam or air and permits the drill or other machine to be kept in use until it is convenient to replace the damaged part. When a piece of hose is damaged in one or two places, the damaged part may be cut out and the good pieces united by means of the company's special splicing clamp.

THE AMERICAN INSTRUMENT COMPANY, Newark, N. J., will make a very interesting exhibit at Atlantic City, N. J., in connection with the convention of the National Electric Light Association next week. For some months past this company has been equipping its factory at Newark, and the first instruments shown anywhere will be those displayed at Atlantic City. A keen desire has been shown to become fully posted concerning these instruments. The exhibit will include the direct-current volt-meters and ammeters of switchboard and portable types, together with instrument parts unmounted, and an important line of ammeter shunts of new design. Mr. A. O. Benecke, chief engineer, will have personal charge of the exhibit, and will be assisted by James G. Biddle, the president, and T. G. Seixas, New York representative.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has sold recently to the Public Service Corporation, of New Jersey, two 500-kilowatt generators, to be used for power purposes at Paterson, N. J. An order has recently been placed with the company for an engine-type generator of 100 kilowatts capacity, to be used as an exciter for a large turbo-generator recently installed at the Philadelphia Rapid Transit Company's station at Second and Grand avenues, Philadelphia, Pa. A contract for two 500-kilowatt generators has recently been placed by the Pittsburg & Lake Erie Dock Company, of Fairport Harbor, Ohio. The company has recently secured a contract from the Elliott Laundry Company, of Baltimore, Md., for an electrical equipment consisting of twenty motor outfits, ranging from one-quarter to fifteen horse-power, for driving various laundry machines, and one generator of eighty kilowatts capacity for additional power.

THE GOULD STORAGE BATTERY COMPANY, New York city, has recently organized a special telephone battery department to look after its rapidly increasing business in storage batteries for telephone service. A corps of experienced engineers has been engaged to devote its entire time to this application of the battery. The Gould company is not a newcomer into the telephone field. It was over three years ago that one of the most important telephone companies in this country placed its first order for Gould storage batteries as a trial installation, which was subsequently followed by orders for the similar equipment of six additional exchanges. The Gould plate has a large contact surface for active material which is developed out of the lead of the blank itself by patented process of "spinning" the surface of the blank into numerout thin ribs. Only chemically pure rolled lead is employed, the great density and uniformity of which are prominent factors in securing high economy and long life.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will make an elaborate exhibit at the Atlantic City convention of the National Electric Light Association next week. The company extends an invitation to all members and visitors to visit its booth, where a number of pieces of apparatus manufactured by it will be on exhibition in operating condition. An opportunity will be afforded for the examination of a single-phase elevator equipment, together with its controller. The interest with central station men and others have lately taken in the introduction of single-phase elevator equipments has been very great during the past six or eight months. In addition to the elevator equipment the company will make a novel exhibit of transformers. The case of a standard transformer has been so cut away that the coils and sheet iron may be plainly seen. This will give a very good opportunity of studying the construction of these transformers. The instrument department of the company will make an exhibit very attractive to switchboard builders and contractors. The line of switchboard and testing instruments will be very complete, two instruments of particular interest being the new combination voltage and frequency indicator and the new lamp testing volt-wattmeter. This latter instrument is being used with great success by the complaint departments and the new business departments of central stations.